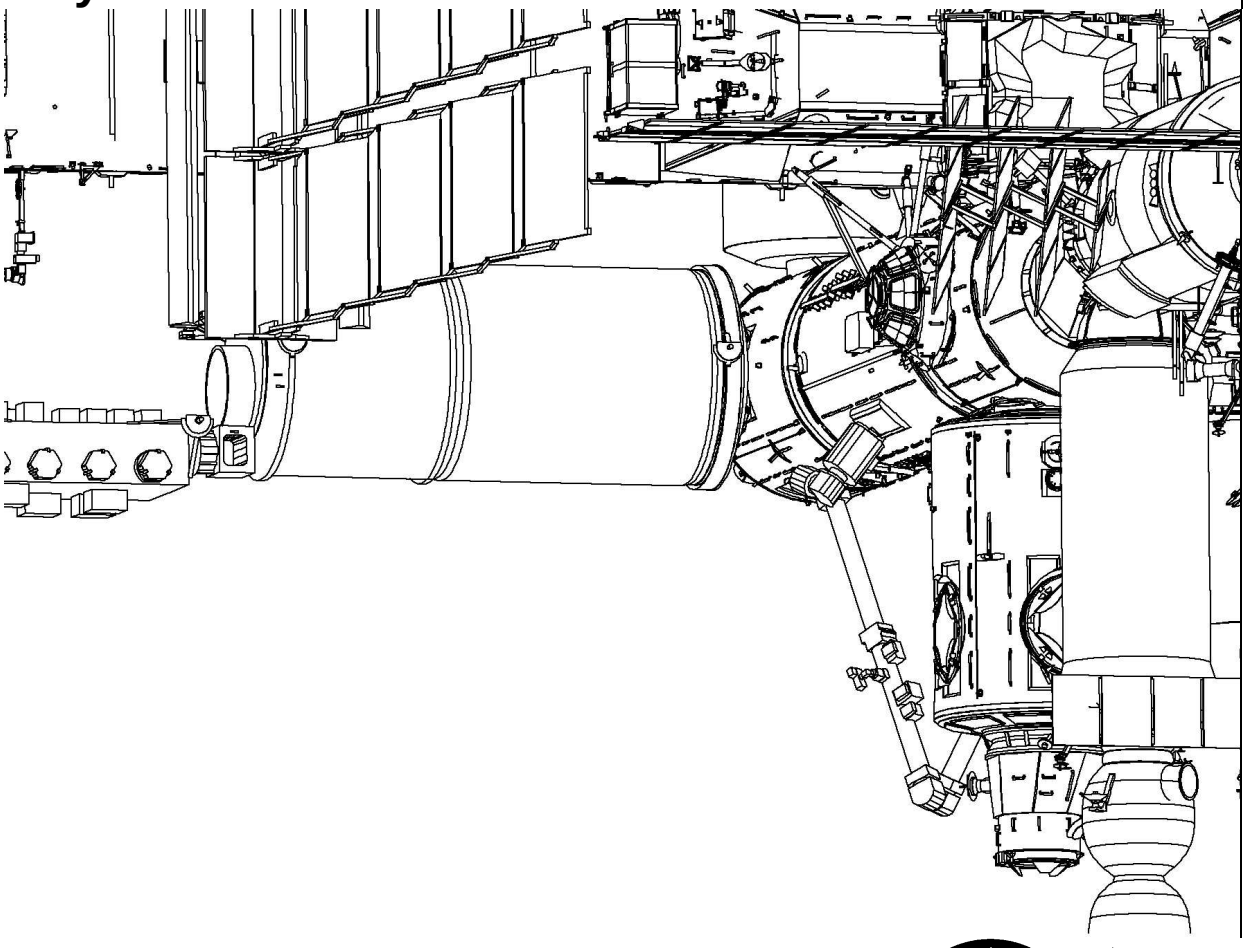
On-Orbit Assembly, Modeling, and Mass Properties Data Book

Volume I

International Space Station Program

July 2003



National Aeronautics and Space Administration
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VOLUMES I AND II

This revision of the *Data Book* was segmented into two volumes due to the document size and because of a smaller customer base requiring data in Volume II. Volume I contains free flying configuration properties necessary to fulfill the requirements of the *ISS Technical Task Agreement JT-33*. In Volume II the mass property and aerodynamic data are organized into a multi-body system utilized by analysts. Volume II provides data used by a limited number of customers within the ISS analysis community.

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INTERNATIONAL SPACE STATION

ON-ORBIT ASSEMBLY, MODELING, AND MASS PROPERTIES

DATA BOOK

PREFACE

This document was constructed by using the November 2002 NASA approved Assembly Matrix and the April 2003 Strategic Stage Mass Property Definition for the United States On-Orbit Segment (USOS). Both of these documents were made by the Assembly and Configuration office.

The contents of this document are to be consistent with the tasks and products prepared by the International Space Station Program (ISSP) participants as specified in *Space Shuttle Program (SSP) 50011-01, Concept of Operation and Utilization, Volume I: Principles* and *SSP 50200-02, Station Program Implementation Plan, Volume II, Program Planning and Manifesting.*

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INTERNATIONAL SPACE STATION

ON-ORBIT ASSEMBLY, MODELING, AND MASS PROPERTIES

DATA BOOK

CONCURRENCE

JULY 2003

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INTERNATIONAL SPACE STATION

ON-ORBIT ASSEMBLY, MODELING, AND MASS PROPERTIES

DATA BOOK

LIST OF CHANGES

JULY 2003

Data Book	*Entry Date*		*Change*		*Paragraphs*
VOLUME I Revision Q Supplemental	July 2003		Baseline		All
	July 10, 2003		Element properties tables (on P87 – NASDA JEM PM 17A Stage)		7-15, 20, 21, 25, 32, 36, 47, 72, 87

VOLUME II Revision Q Supplemental	July 2003		Baseline		All

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1.0 INTRODUCTION

The *International Space Station (ISS) On-Orbit Assembly, Modeling and Mass Properties Data Book* provides a program approved, baseline representation of the ISS as modeled using the November 2002 Assembly Matrix and April 2003 Strategic Stage Mass Property Definition for United States On-Orbit Segment (USOS), created by the Assembly and Configuration Team. The Systems Engineering, Modeling, and Design Analysis (SEMDA) Laboratory of the Lockheed Martin Space Operations (LMSO) Company in Houston, Texas produces this document for the National Aeronautics and Space Administration (NASA) Systems Engineering Office [EA4] at the Lyndon B. Johnson Space Center (JSC). SEMDA Lab performs the design, development, testing and engineering portions of this work under *ISS Technical Task JT-33, Assembly Analysis.* The JT-33 is a subset of *JT-156, EA Mission Compatibility/Assembly Analysis*. Related sustaining engineering work is performed under the *JSC-EA-2 Operations Analysis/Configuration Modeling Technical Task.*

ISS geometry, mass properties, and on-orbit orientation information was collected from multiple sources, including NASA, Canadian Space Agency (CSA), European Space Agency (ESA), Japanese National Space Development Agency (NASDA), Russian Space Agency (RSA), Rocket Space Corporation – Energia (RSC-E), Khrunichev State Research and Production Space Center (KhSC), and Boeing. This information was used to create solid model representations of ISS hardware in a computer aided engineering package. These computer-generated solid model components were then organized into 6 configurations. These configurations represent stages from the Second Post-Stage 10A to Stage 14A. This range was chosen to meet Verification Analysis Cycle (VAC) commitments while minimizing rework due to uncertainties in the ISS assembly sequence and manifest.

1.1 PURPOSE OF DATA BOOK

This *Data Book* provides comprehensive assembly and mass and aerodynamic properties data for the full range of the ISS construction activities with the following information provided for each configuration:

1) Detailed description

2) Solid model isometric illustration

3) Total ISS on-orbit mass

4) Center of mass location

5) Inertia tensor*

6) Principal moments of inertia

7) Principal to body Euler rotation angles

8) Projected areas

9) Center of pressure offset matrix.

Configurations can contain other extra data sets as described in detail in Section 7.0 Configuration Data, including these items:

1) Element interfaces

2) Element properties*

3) Element dimensioned four-view drawings

4) Orbiter attach point location

5) Mass properties for an attached Orbiter vehicle*

* Inertia matrix off-diagonal elements are negative integrals on these pages.

1.2 SCOPE OF DOCUMENT

This document provides baseline ISS on-orbit body and configuration mass and aerodynamic properties for selected configurations. The SEMDA Lab provides this information to NASA, CSA, ESA, NASDA, RSA, RSC-E, KhSC, and Boeing personnel for analysis using the November 2002 NASA approved Configuration List, Table 4.0-1.

1.3 PRECEDENCE

Unless noted otherwise, information contained in this document will be consistent with ISS Program (ISSP) and Mission Operations Directorate (MOD) documentation:

- Assembly Matrix on the OM5 Assembly & Configuration Web Page (http://iss-www.jsc.nasa.gov/ss/issapt/assembly/assembly.html)

- Mission specific Assembly Overview documents

When this *Data Book* conflicts with any ISS documents above concerning the ISS assembly and operational information, the documents listed above take precedence over the information contained in this document.

The body and configuration mass and aerodynamics properties data sets contained in this document take precedence over other ISS documentation with the exception of the following mission specific data resources:

- Mass properties information for a specific VAC for an upcoming flight. The VAC data will be generated using the Mass Properties Sustaining Engineering Tool (MPSET) prior to launch.

- Mass properties information exchanged between NASA and RSC-E within 20 days of an on-orbit event, or series of events, for data synchronization purposes. These exchanges, defined in formal protocols, ensure that Mission Control-Moscow and Mission Control-Houston use consistent ISS mass properties data sets.

- Validated SEMDA Lab data updates released between a *Data Book* delivery and a specified on-orbit event.

1.4 CUSTOMER SUPPORT

Questions or comments regarding this document or corresponding ISS solid models may be directed to Mansour Falou/LMSO. Questions about mass properties used to generate data in this document may be directed to Oliver Philippi/LMSO.

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The SEMDA Lab team created the ISS data in this document. To obtain information pertaining to the contents, contact the individuals listed below via Mansour Falou.

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	Brad Henry	Theresa Tran
Mass Properties:	Oliver Philippi	Vera Annenkova
MODGEN:	Mansour Falou	
Documentation:	SEMDA Team	
Preparation:	SEMDA Team	

Data from this document can be found electronically via these routes:

For anonymous users and for users within the JSC domain, using a FTP utility:

ftp address: lmso.external.lmco.com/

User name: anonymous

Password: [use electronic mail address]

Or using a browser such as Netscape or Internet Explorer

ftp address: ftp://lmso.external.lmco.com/

Select the appropriate directory for data.

This document can also be found at the SEMDA web page at:

WWW address: http://seat1.jsc.nasa.gov/semda

The “seat2” FTP server is no longer accessible for FTP services.

Work is underway to have links to all SEMDA products in the SEMDA web page. Users will be informed as these links and other improvements become available.

These servers are maintained as a courtesy to ISS data users. Contact Mansour Falou at 281-333-6326 for problems related to electronic data access.

1.5 SOFTWARE TOOLS

Four software tools were used to determine ISS mass and area properties:

1. *Integrated Design Engineering Analysis Software (I-DEAS) Master Series Version 7m2;*
2. *stl_dump;*
3. *Universal Translator (UT);*
4. *MODel GENerator (MODGEN).*

I-DEAS is a commercial computer-aided engineering package of the Structural Dynamics Research Corporation (SDRC). In 1985 the Langley Space Station Office and the SDRC undertook development of a spacecraft analysis package entitled *I-DEAS*^{2}. That software package was an integration of *I-DEAS* with a family of NASA analysis programs. The key conduit between *I-DEAS* and the programs was the *MODGEN*. The *MODGEN* converts a universal file, an *I-DEAS* output file, into a form usable by the programs. *MODGEN* also calculates properties. *MODGEN* was upgraded multiple times since 1985 by Structural Dynamics Research Corporation (SDRC) and LMSO. In 1993 SDRC released a completely re-architectured *I-DEAS* called *I-DEAS Master Series*. The previous architecture ended with *I-DEAS VI*. In 2001, Electronic Data Systems (EDS) purchased SDRC.

MODGEN and other SEMDA Lab supported software require *I-DEAS VI* universal files for input. Accordingly the SEMDA Lab developed software to recreate *I-DEAS VI* universal files from *Master Series* output. The principle software tools used were *stl_dump* and the *UT*.

The "*stl_dump*" program automatically generates stereolithography files in "*STL*" format of 3D Systems, Inc. The *UT* reads these and *Master Series* "archive" files to create *I-DEAS VI* universal files.

1.6 DISCLAIMER

Geometrical information contained in this document is included for general reference purposes to aid detailed analysis and operations planning activities.

Vehicle configurations and dimensions shown in this document are derived from data for static, on-orbit element configurations. Dynamic conditions due to applied loads, including internal pressure deformations of individual elements, and thermal effects are neither depicted nor dimensioned in this document. Detailed design, analysis, and operations planning tasks might need to incorporate on-orbit dynamic effects and deflections.

The SSP-ISS thermal control and proximity operations, plume impingement, structures, and flight control Joint Technical Working Groups (JTWG) should be consulted in determining on-orbit relative dynamic deflections and expected relative dimensions for specific vehicle or element components.

Dimensional tolerances used in this document are defined below. Users of this document are cautioned that dimensions and therefore tolerances, in this document are for General Reference Purposes Only!

	Inches	Millimeters
Linear Dimensions:	±3.0	±76
Angular Dimensions:	±0.5°	

Or 10% of major dimensions whichever is less unless otherwise specified.

NOTE: No detailed design, manufacturing, or production data are included in this document or related electronic materials released for public access.

2.0 DOCUMENTATION

The following documentation, used in creation of this *Data Book*, is separated into categories for specific areas and sources of data.

2.1 APPLICABLE DOCUMENTS

ISS Mass and Mass Properties [VIPeR and NASA]

- Resource Analysis and Integration (RAI) Team, MIP Annex 1, *Launch and Return Configurations - Payload Mass Properties Analyses. [August 2002]*
- Mass Properties Verification and Sustaining Engineering Tool *(MPVSET), version 5.1 – Updated to include ISS Stage 9A Postflight Mass Properties Data.*

Orbiter Mass Properties [NASA]

- *Shuttle Operational Data Book (SODB) National Space Transportation System (NSTS) 08934, Volume II,* Amendments for 12A as released through September 2002.

Geometry [Boeing/NASA]

- Boeing Physical Integration Team (PIT) electronic geometry files [May 2003]

Geometry [Boeing PIT/CSA]

- Electronic geometry files [September 2002]

Geometry [Boeing PIT/ESA]

- Electronic geometry files [September 1999]

Orbiter Docking System (ODS) Androgynous Peripheral Attach System (APAS**)** Mating Geometry:

- *NSTS-21000-Interface Development Document (IDD)-ISS*
- *NSTS 07700, Volume X*

Geometry [RSA]

- Video conference and facsimile communications with Russian engineers.
- Periodic Technical Interchange Meeting (TIM) discussions [Coordinated with Boeing VIPeR and NASA ISS program officials]
- Euclid and *AutoCAD International Graphics Exchange Standard (IGES)* software file transfers from Energia [October 1999]
- *EN-01 FGB Design Description Document Khrunichev State Research and Production Space Center (KhSC),* Salyut Design Bureau [July 1998]
- *Research Program Office (RPO) 1342 Russian Soyuz-TM Technical Data Book, Revision C,* Space Station Program Office [November 1998]
- *RPO-1551 Russian Service Module Technical Data Book, Basic,* Space Station Program Office [December 20, 1996]

- *RPO-2438 Russian Progress M1 Vehicle Technical Data Book, Preliminary Edition,* Space Station Program Office [February 1998]
- *Description of Pirs DC 1, S. P. Korolev,* Rocket Space Corporation "Energia" [March 31, 2000].

Coordinate Systems

- *SSP30219 ISS Reference Coordinate Systems Document, Revision E* [November 29, 2000]
- *Solar Array Rotational Conventions* *http://viperweb.jsc.nasa.gov/mai/solarradiatororient.asp* [December 1, 1999]

Assembly Sequences

- *D684-10514-2, Assembly Sequence and Manifest Document, Issue A, Draft 1* [February 7, 1994]
- *4-18 Approved Assembly Sequence* [April 18, 1994]
- *6-30 Approved Assembly Sequence* [June 30, 1994]
- *9-28 Space Station Control Board (SSCB) Approved Assembly Sequence* [September 28, 1994]
- *Design Analysis Cycle (DAC) 2 Post-Vehicle Integrated Product Team Preliminary Assembly Sequence* [March 23, 1995]
- *ISS Assembly Sequence, Revision A* [June 13, 1995]
- *Preliminary ISS Assembly Sequence, Revision B* [April 15, 1996]
- *ISS Assembly Sequence, Revision B* [September 26, 1996]
- *ISS Assembly Sequence, Revision C* [September 4, 1997]
- *SSCB Approval* [September 30, 1997]
- *ISS Assembly Sequence, Revision D* [May 29, 1998]
- *ISS Assembly Sequence, Revision E* [June 1, 1999]
- *Rev E, Design Change Notice (DCN)-04* [March 2000]
- *Interim ISS Assembly Sequence, Revision F-3* [December 2000]
- *Interim March 2001 Assembly Matrix*
- *August 2001 Assembly Matrix [October 02, 2001]*
- *March 2002 NASA approved configuration list*
- *ISS Assembly Matrix [November 2002]*
- *Strategic Stage Mass Property Definition for USOS [April 2003]*

2.2 CHANGES TO DATA BOOK FORMAT

No baseline assembly sequence was provided by the ISS program after the Revision F-3 assembly sequence. Since there was no assembly sequence to be used as the main reference in creating the Revision Q Mass Properties Data Book, the ISS Assembly Matrix updated November 2002 and the Strategic Stage Mass Property Definition for USOS updated April 2003, released by the Assembly and Configuration Team, is used as the main reference.

Configuration numbers were omitted from the steps that are shown in the book other than Stage 10A Stage 2, since configuration numbers have not been assigned to the flights beyond 10A. Information on which orbital vehicle is assigned to the flights in the book have been omitted due to the lack of information.

Because of the lack of a baseline assembly sequence, the ISS program requested the omission of configuration dates.

The latest assembly matrix and integrated flight schedule document can be found on the Assembly and Configuration web page at the following address:

http://iss-www.jsc.nasa.gov/ss/issapt/assembly/assembly.html

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3.0 COORDINATE SYSTEMS

The following sections define coordinate systems used in this document to describe ISS and Space Shuttle orientations.

3.1 LOCAL VERTICAL-LOCAL HORIZONTAL

The Local Vertical/Local Horizontal (LVLH) coordinate system, illustrated in Figure 3.1-1, is defined with the Z_{LO} axis pointing to the nadir. The Y_{LO} axis points perpendicular to the orbital plane as a vector cross product of the radius and velocity vector. The X_{LO} axis is the horizontal projection of the velocity vector, a vector cross product of the Y and Z unit vectors, that defines the local horizontal axis. The center of this right-handed orthogonal system is located at the vehicle center of mass.

3.2 SPACE STATION ANALYSIS COORDINATE SYSTEM

The Space Station Analysis Coordinate System (SSACS), illustrated in Figure 3.2-1, is a right-handed Cartesian, body-fixed coordinate system that corresponds to LVLH flight orientation. The origin is located at the geometric center of the mid-ship Integrated Truss Segment (ITS) S0. The longitudinal x-axis of multiple core modules, including the Zarya Functionalni Gruzvoi Blok (FGB) and Unity Node 1, is parallel with the analysis coordinate system axis X_A, positive in the direction of the velocity vector. Positive Y_A axis runs parallel with the starboard truss from the center point at S0. Axis Z_A completes the triad, pointing to the nadir.

3.3 ORBITER STRUCTURAL REFERENCE SYSTEM

The Orbiter Structural Reference System (OSRS), illustrated in Figure 3.3-1, is defined with the origin in the Orbiter plane of symmetry 400 inches below the center line of the payload bay and 236 inches forward of the Orbiter nose. The X_O longitudinal axis runs parallel and 400 inches below the payload bay centerline, directed positive from the vehicle nose toward its tail. The vertical Z_O axis resides in the vehicle plane of symmetry perpendicular to the X_O axis and directed positive upward from the payload bay in the landing attitude. The Y_O axis completes the right-hand coordinate system, directed positive from the Orbiter centerline out to the tip of the starboard wing.

Figure 3.3-1 presents basic Orbiter dimensions and various positions of the ODS. The ODS provides an Orbiter docking interface with the ISS. The Orbiter side view indicates three extended ODS positions. The Fully Extended Position, Z=[479.76”], represents the maximum ODS interface extension limit. The Ready-To-Dock Position, Z=[475.51”], represents the standard ODS interface extension at first contact to the ISS docking interface. The Structural Lockup Position, Z=[460”], represents the ODS interface extension when the Orbiter securely docks to the ISS docking interface.

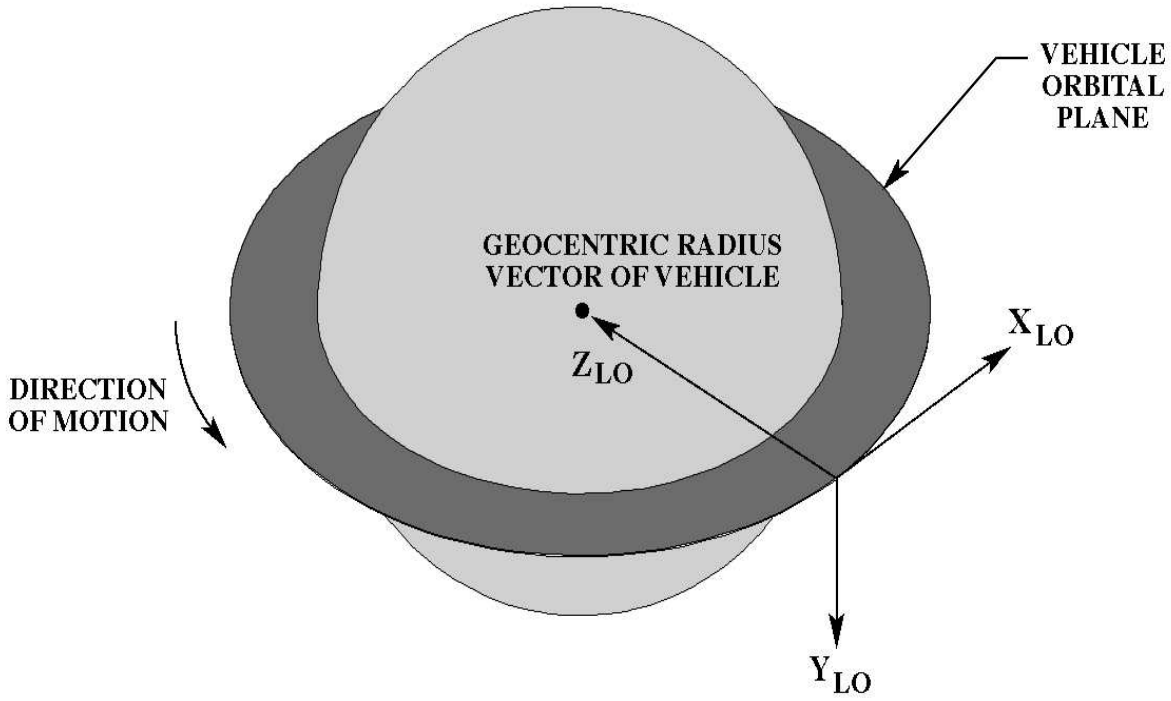

Figure 3.1-1 LVLH Frame

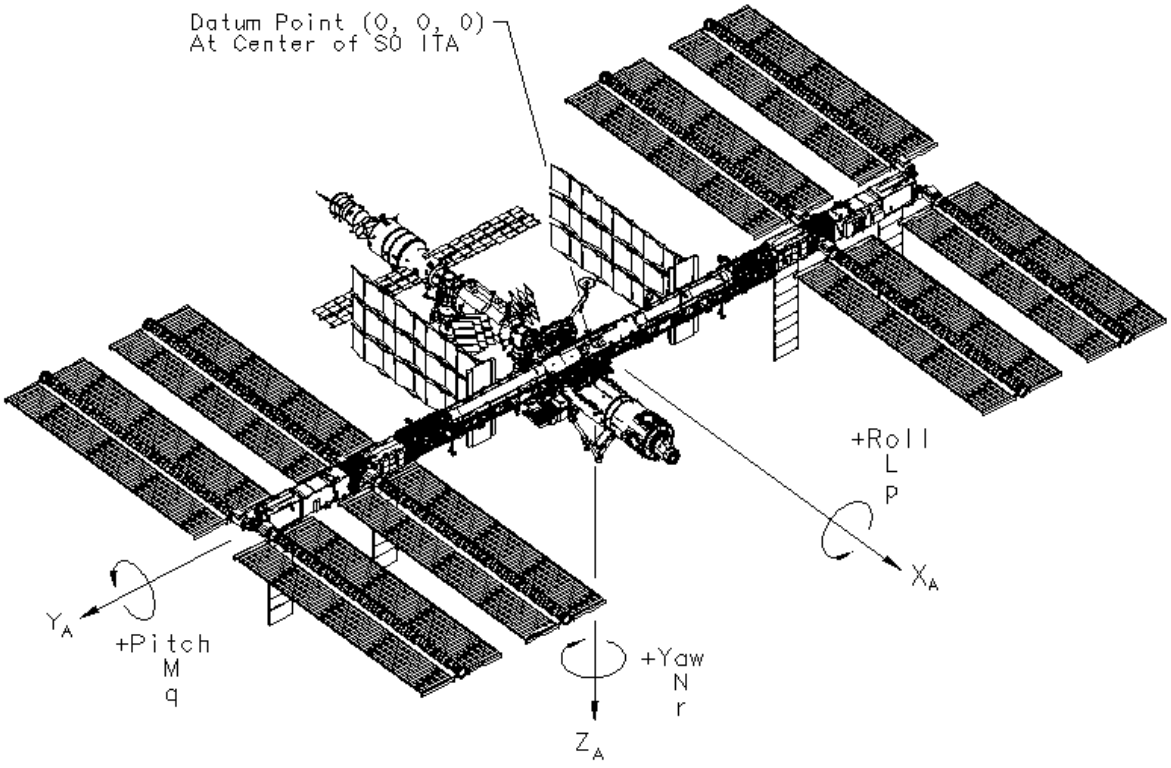

Figure 3.2-1 SSACS Frame

The Orbiter top view indicates two ODS positions in the cargo bay. The ODS Aft position, X=[731.6”], was used for STS -88, ISS Stage 2A, in 1998. The ODS Forward position, X=[649”], has been planned for use on all other Orbiter missions.

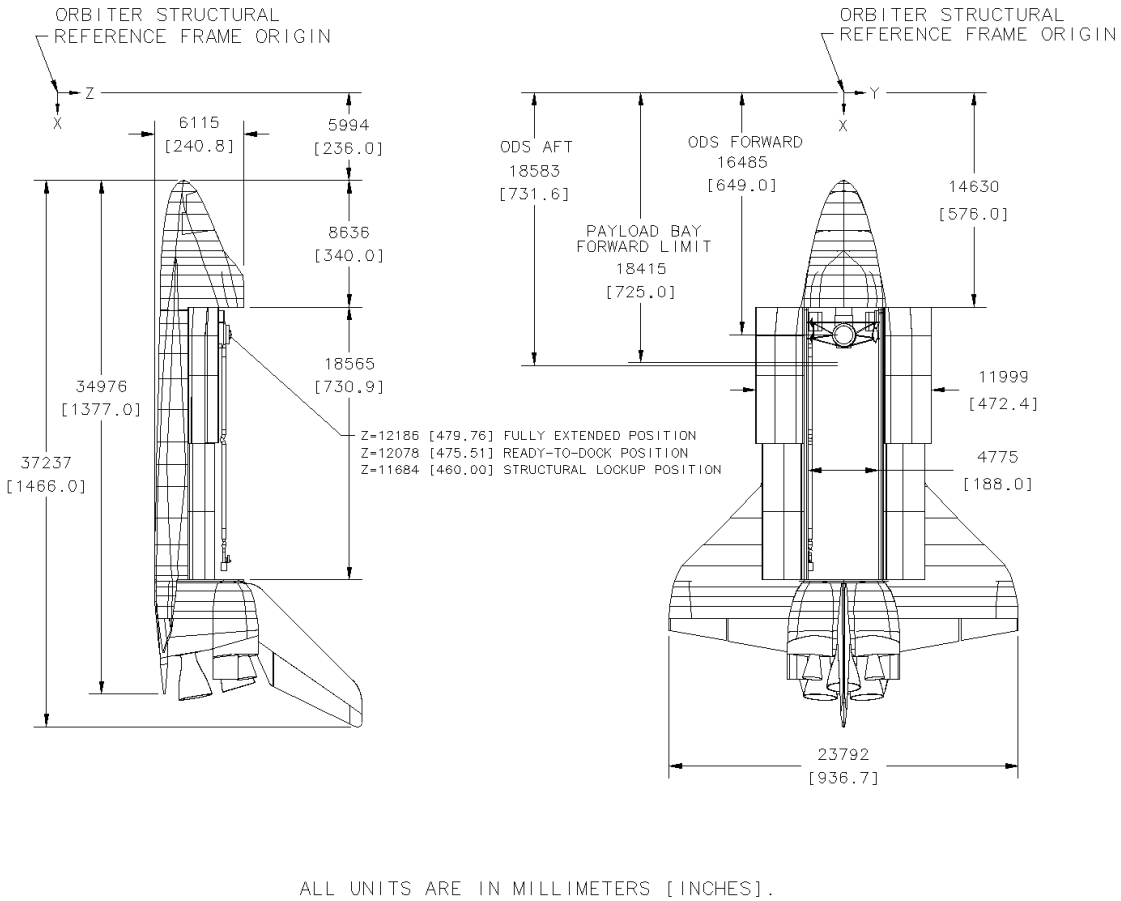

Figure 3.3-1 OSRS Frame

3.4 PRINCIPAL AXES

Principal body axes coordinate systems are determined in this document for each ISS configuration and stage described. In each case, the origin of the principal axes coordinate system is located at the configuration center of mass. In the solution of the eigen value problem for identifying principal axes, principal moments of inertia are assigned in a manner to minimize rotations aligning ISS analysis coordinates and principal axes coordinates. The re-orientation of ISS axes from principal coordinate alignment to ISS analysis axis alignment uses a yaw-pitch-roll Euler angle sequence.

3.5 RSA ANALYSIS COORDINATE SYSTEM

This system, illustrated in Figure 3.5-1, is a right-handed Cartesian, body-fixed coordinate system. The origin is located at the center of the aft side of the aft Zvezda Service Module bulkhead. Coordinates of the RSA origin in the SSACS are [-35339, -6, 4142] millimeters. The x-axis, X_R, is parallel to the x-axis of the SSACS but is positive in the opposite direction of the velocity vector. The positive y-axis, Y_R, runs parallel with the Z_A axis, pointing zenith. The z-axis Z_R, completes the triad.

3.6 INFORMATION REPORTING

Moments of inertia, products of inertia and centers of pressure reported in this document are given with respect to the specific element, body, or vehicle center of mass. The center of mass and other significant points are reported with respect to the SSACS frame, as defined in Section 3.2.

All configuration illustrations contain a Cartesian triad. The triad is not positioned at the vehicle center of mass. The triad indicates the orientation of the SSACS frame.

Aerodynamic centers of pressure are referenced in the SSACS frame to specific element, body, or vehicle center of mass and not the modeling origin.

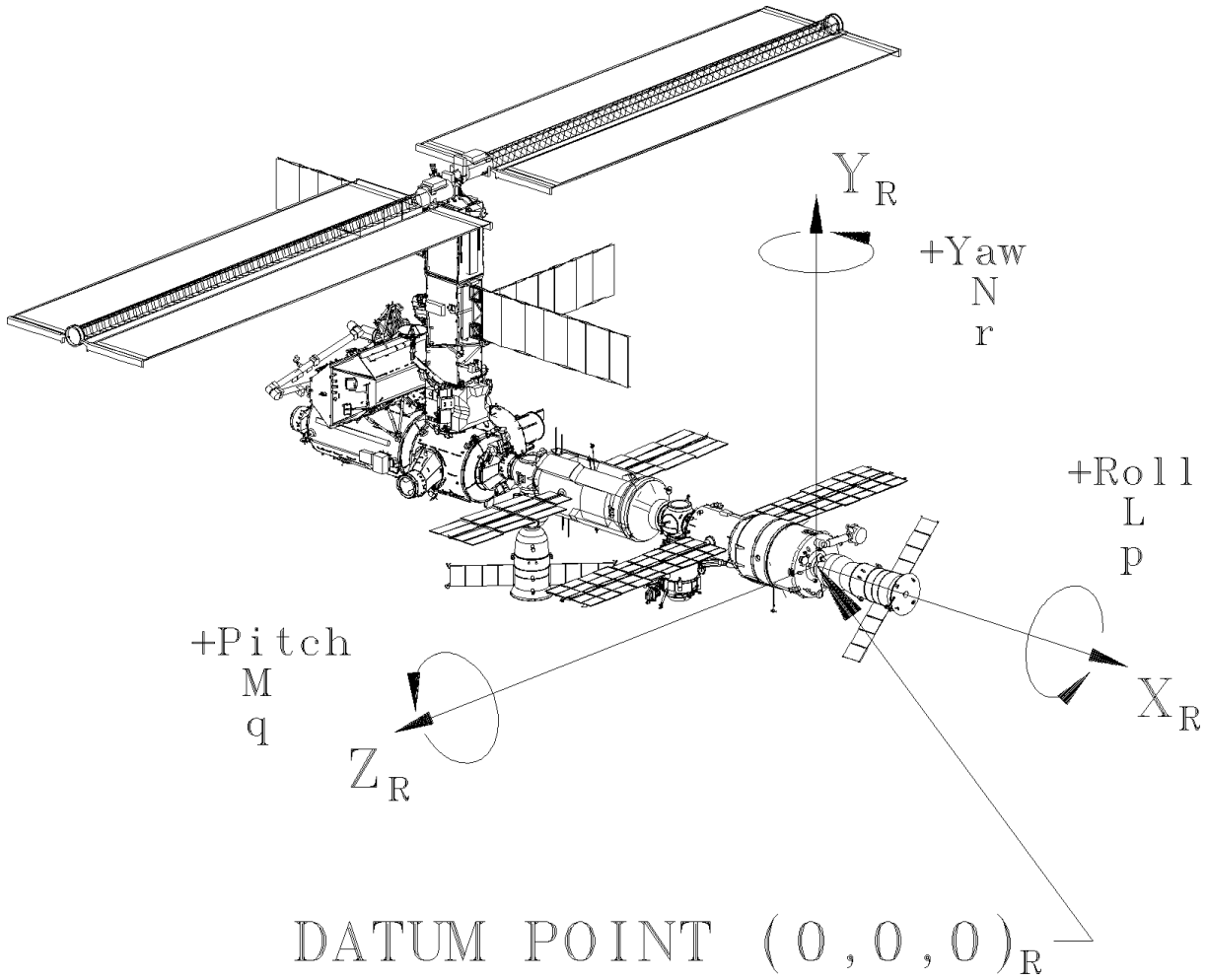

Figure 3.5-1 RSA Analysis Coordinate System

4.0 CONFIGURATION LIST

The Configuration List contains 6 steps and their respective descriptions analyzed in this document. Selected configurations depict the ISS in a free flying mode, including before and after certain EVA tasks occur, or after selected vehicle movements take place. Each configuration type has a special designation. The names carry the designation of the space agency supplying the manifested cargo and the launch number associated with the specific deliverable. Configuration numbers are fixed to specific on-orbit events by NASA – RSA protocol in the months preceding an on-orbit event. Because of late sequence changes, configuration numbers might become non-sequential. Therefore, step numbers 1-6 have been introduced for this document. This procedure provides a sequential, continuous numbering scheme needed for certain analysts.

Examples include:

_After Rendezvous [_AR]	A stage configuration with the Orbiter attached, After Rendezvous
_Intermediate [_INT]	A stage configuration with the Orbiter attached, Intermediate
_Before Separation [_BS]	A stage configuration with the Orbiter attached, Before Separation
_After Separation [_AS]	A free flying configuration, After Separation of a Progress, Soyuz, or Orbiter
_After SeparationX [_ASX]	In the case of Russian vehicles, X defines each additional vehicle redocking that occurs. In the case of Shuttle flights, X defines each additional After Separation (AS) configuration that occurs prior to the next shuttle flight. (AS1 is always after Orbiter separation.)

Note that a series flight number is often assigned to specific payloads for American (A) and Russian (R) assembly-build stages. Because the order that those payloads are manifested can change, the stages might not occur in numerical order for a given series. Thus, Stage 10A follows Stage 11A.

A American [NASA] assembly-build Space Shuttle Mission

P Progress [RSA] vehicle re-supply mission

R RSA launched assembly-build mission

S Soyuz [RSA] vehicle replacement mission

UF Utilization Flight [NASA] Space Shuttle Mission

ULF Utilization Logistic Flight [NASA] Space Shuttle Mission

Table 4.0-1, applies information from various sources to organize model configuration assemblies.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
-	-	1A/R	Zarya FGB module launch.
-	-	2A	STS-88 Orbiter carried Unity Node 1, PMA 1 and PMA 2 assembly which was attached to Zarya FGB forward.
001	-	STAGE 2A.1	ISS after STS-96 Orbiter separation and reboost activities.
002	-	STAGE 2A.2A_AR	ISS with STS-101 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA 2.
003	-	STAGE 2A.2A_BS	ISS with STS-101 Orbiter before separation [fully unloaded].
004	-	STAGE 2A.2A_AS	ISS after STS-101 separation following logistics and outfitting transfers with Zarya FGB and Unity Node 1. Assemble and move Strela Cargo Boom-2 from PMA 2 to PMA 1.
005	-	STAGE 1R	ISS with Zvezda Service Module after docking to Zarya FGB aft.
006	-	FLIGHT 1P	ISS with 1P Progress M1-3 after docking to Zvezda Service Module aft.
007	-	STAGE 2A.2B_AR	ISS with STS-106 Orbiter after rendezvous [fully loaded] to PMA 2.
008	-	STAGE 2A.2B_BS	ISS with STS-106 Orbiter before separation [fully unloaded]; Extravehicular Activity (EVA)s completed.
009	-	STAGE 2A.2B_AS	ISS after STS-106 Orbiter separation following logistics and outfitting transfers with Zarya FGB, Unity Node 1, Zvezda Service Module, and 1P Progress.
011	-	STAGE 3A_AR	ISS with STS-92 Orbiter after rendezvous [fully loaded] to PMA 2.
012	-	STAGE 3A_INT	ISS with STS-92 Orbiter after ITS Zenith 1 (Z1) berthed to Unity Node 1 zenith Common Berthing Mechanism (CBM). Z1-mounted Space to Ground Antenna (SGANT), know as the Ku-band Antenna, remains stowed.
013	-	STAGE 3A_BS	ISS with STS-92 Orbiter before separation [fully unloaded]. Relocate S-band Antenna Structural Assembly (SASA) and Direct Current-to-Direct Current Converter Units (DDCUs) and install Ku-band Antenna Z1. Berth PMA 3 to Unity Node 1 nadir CBM. Deploy Z1 utility tray; Relocate grapple fixture and keel pin.
014	-	STAGE 3A_AS	ISS after STS-92 Orbiter separation.
015	-	FLIGHT 1P_AS	ISS after 1P Progress M1-3 separation from Zvezda Service Module aft.
016	-	FLIGHT 2R_AR1	ISS with 2R Soyuz TM-31 after docking to Zvezda Service Module aft. 2R Soyuz carried the first ISS crew.
010	-	FLIGHT 2P_AR	ISS with 2P Progress M1 after docking to Zarya FGB nadir.
017	-	FLIGHT 2P_AS	ISS after 2P Progress M1 separation from Zarya FGB nadir following unloading of propellant and dry cargo, and loading of waste.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
018	-	STAGE 4A_AR	ISS with STS-97 Orbiter after rendezvous [fully loaded].
019	-	STAGE 4A_INT1	ISS with STS-97 Orbiter with ITS Port 6 (P6) held in the parking position. Solar arrays and radiators remain stowed in launch position.
020	-	STAGE 4A_INT2	ISS with STS-97 Orbiter after ITS P6 attached to Z1 truss zenith. Solar arrays and radiators remain stowed in launch position.
021	-	STAGE 4A_BS	ISS with STS-97 Orbiter before separation. Rotate P6 keel pin; Deploy P6 solar arrays and forward radiator. Relocate S-band Antenna from Z1 to P6 zenith. Deploy P6 aft radiator, deploy EVA Bag on P6; deploy Plasma Probe to P6 aft zenith surface.
022	-	STAGE 4A_AS	ISS after STS-97 Orbiter separation.
023	-	FLIGHT 2P_AR2	ISS with 2P Progress M1 after docking to Zvezda Service Module aft.
024	-	FLIGHT 2P_AS2	ISS after 2P Progress M1 separation from Zvezda Service Module aft.
025	-	STAGE 5A_AR	ISS with STS-98 Orbiter after rendezvous [fully loaded].
026	-	STAGE 5A_INT1	ISS with STS-98 Orbiter after PMA 2 moved to Z1 forward [rotated 102 degrees].
027	-	STAGE 5A_INT2	ISS with STS-98 Orbiter after Destiny Lab berthed to Unity Node 1 forward CBM. Deploy P6 starboard radiator. Remove Ku-band Antenna gimbal locks. Install Lab Power and Data Grapple Fixture (PDGF) and window shutter gearbox.
028	-	STAGE 5A_BS	ISS with STS-98 Orbiter [fully unloaded] before separation. PMA 2 moved from Z1 forward to Destiny Lab forward CBM, S-band spare on Z1.
029	-	STAGE 5A_AS	ISS after STS-98 Orbiter separation.
030	-	FLIGHT 2R_AR2	ISS with 2R Soyuz TM-31 after docking to Zarya FGB nadir. 2R Soyuz relocated from Zvezda Service Module aft to Zarya FGB nadir.
031	-	FLIGHT 3P_AR	ISS with 3P Progress M-44 after docking to Service Module aft.
032	-	STAGE 5A.1_AR	ISS with STS-102 Orbiter after rendezvous [fully loaded].
033	-	STAGE 5A.1_INT1	ISS with STS-102 Orbiter after portside Early Communications (ECOMM) Antenna removed and stowed inside Unity Node 1. Install Lab Cradle Assembly (LCA) and PDGF Rigid Umbilical. PMA 3 moved to Unity port CBM. Berth Leonardo Multi-Purpose Logistics Module (MPLM) to Unity nadir.
034	-	STAGE 5A.1_INT2	ISS with STS-102 Orbiter after External Stowage Platform (ESP) and one Pump and Flow Control Subassembly (PFCS) installed on Destiny Lab forward. Before unloaded Leonardo off Unity Node 1 nadir.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
035	-	STAGE 5A.1_BS	ISS with STS-102 Orbiter before separation with MPLM returned, EVAs complete.
036	-	STAGE 5A.1_AS	ISS after STS-102 Orbiter separation.
038	-	FLIGHT 3P_AS	ISS after 3P Progress M-44 separation from Zvezda Service Module aft following unloading of propellant and dry cargo, and loading of waste.
030d	-	FLIGHT 2R_AR3	ISS with 2R Soyuz TM-31 after docking to Zvezda Service Module aft. Relocate 2R Soyuz from Zarya FGB nadir to Zvezda Service Module aft.
040	-	STAGE 6A_AR	ISS with STS-100 Orbiter after rendezvous [fully loaded].
041	-	STAGE 6A_INT1	ISS with STS-100 Orbiter after Launch Deploy Assembly (LDA) mechanism secures Spacelab Pallet (SLP) to LCA.
042	-	STAGE 6A_INT2	ISS with STS-100 Orbiter with Ultra High Frequency (UHF) Antenna deployed and attach Space Station Remote Manipulator System (SSRMS) to Destiny Lab PDGF. Install fully loaded Raffaello MPLM on Unity Node 1 nadir.
043	-	STAGE 6A_INT3	ISS with STS-100 Orbiter before SLP off Destiny Lab. Remove Starboard ECOMM antenna and stowed in Unity. Install DC Switching Unit (DCSU) on ESP.
044	-	STAGE 6A_INT4	ISS with STS-100 with SLP returned to payload bay by the SSRMS. Before the unloaded Raffaello MPLM removed from Unity Node 1 nadir.
045	-	STAGE 6A_BS	ISS with STS-100 Orbiter before separation with MPLM returned. EVAs completed.
046	-	STAGE 6A_AS	ISS after STS-100 Orbiter separation.
047	-	FLIGHT 2S_AR1	ISS with 2S Soyuz TM-32 after docking to FGB nadir. Soyuz clocked at 45. Prior to this configuration, SM Transfer Docking Cone was relocated to SM nadir port.
048	-	FLIGHT 2R_AS3	ISS after 2R Soyuz TM-31 separation from Service Module aft.
039	-	FLIGHT 4P_AR	ISS with 4P Progress M1-6 after docking to Zvezda Service Module aft.
049	-	STAGE 7A_AR	ISS with STS-104 Orbiter after rendezvous [fully loaded].
050	-	STAGE 7A_INT1	ISS with STS-104 Orbiter after Airlock module berthed to Node 1 starboard CBM.
051	-	STAGE 7A_INT2	ISS with STS-104 Orbiter after installation of one O2 and one N2 High Pressure Gas Assembly (HPGA) units on the Airlock.
052	-	STAGE 7A_BS	ISS with STS-104 Orbiter before separation [fully unloaded]. Install Remaining HPGA assembly units.
053	-	STAGE 7A_AS	ISS after STS-104 Orbiter separation.
			ISS PHASE 2 COMPLETE

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
054	-	STAGE 7A.1_AR	ISS with STS-105 Orbiter after rendezvous [fully loaded].
055	-	STAGE 7A.1_INT1	ISS with STS-105 Orbiter after fully loaded Donatello MPLM berthed to Unity Node 1 nadir.
056	-	STAGE 7A.1_INT2	ISS with STS-105 Orbiter after Articulating Portable Foot Restraint (APFR) installed. Install Early Ammonia Servicer (EAS) on P6 truss forward trunnion. Install external attached Payload 1 A and B Materials ISS Experiment (MISSE) on Airlock nadir center High Pressure Gas Tank (HPGT) (#2) and crew lock. Donatello MPLM unloaded, but still on Unity Node 1 nadir. Install Flight 8A and S0 truss LTA cables.
057	-	STAGE 7A.1_BS	ISS with STS-105 Orbiter before separation and with MPLM returned.
058	-	STAGE 7A.1_AS	ISS after STS-105 Orbiter separation.
058c	-	FLIGHT 4P_AS	ISS after 4P Progress M1-6 separation from Zvezda Service Module aft, following unloading of propellant and dry cargo, loading of waste.
058g	-	FLIGHT 5P_AR	ISS with 5P Progress M-45 after docking to Zvezda Service Module aft. 5P carrying the Russian experiment Micro-Particle Capture (MPAC) / Space Environment Exposure Devices (SEEDS).
037	-	STAGE 4R_AR	ISS with Docking Compartment (DC) 1 after docking to Zvezda Service Module nadir. Second Strela Cargo Boom (Strela-1) launched inside DC 1. Universal Instrument Section (UIS) attached to DC 1 nadir.
069	-	FLIGHT 2S_AS1	ISS after 2S Soyuz TM-32 separation from Zarya FGB nadir. Prior to this configuration, an EVA occurs in which the UIS detaches from DC1. Deploy Soyuz docking target on DC1 nadir. Deploy MPAC /SEEDS experiment on SM port nadir handrails. EVA egress ladder is installed on DC1 EVA hatch, and deploy Strela 1 on DC1 starboard side. Install and deploy Boom with antenna on DC1 nadir.
69e	-	FLIGHT 2S_AR2	ISS with 2S Soyuz TM-32 after docking to DC1. This maneuver is required to ensure that 3S can dock to FGB nadir port to support the Orlan based EVA from DC1.
068	-	FLIGHT 3S_AR	ISS with 3S Soyuz TM-33 after docking to FGB nadir. Soyuz clocked 45 deg.
069h	-	FLIGHT 2S_AS2	ISS after 2S Soyuz TM-32 separation from DC1.
059	-	FLIGHT 5P_AS	ISS after 5P Progress M-45 separation from Zvezda Service Module aft. After unloading of propellant and dry cargo; loading waste.
060	-	FLIGHT 6P_AR	ISS with 6P Progress M1-7 after docking to Zvezda Service Module aft.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
063	-	STAGE UF1_AR	ISS with STS-108 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA-2 tail nadir.
064	-	STAGE UF1_INT1	ISS with STS-108 Orbiter after fully loaded MPLM berthed to Unity Node 1 nadir port.
065	-	STAGE UF1_INT2	ISS with STS-108 Orbiter. MPLM is prepared for return, but still attached to Node 1.
066	-	STAGE UF1_BS	ISS with STS-108 Orbiter before separation with MPLM returned.
067	-	STAGE UF1_AS	ISS after STS-108 Orbiter separation.
061	-	FLIGHT 6P_AS	ISS after 6P Progress M1-7 separation from Zvezda Service Module aft after unloading of propellant and dry cargo and loading of waste. Prior to this configuration, relocate Strela 2 from PMA-1 to DC1. Install 2 ISS Ham Radio Antennas WA3 and WA4 on SM handrails 2627 and 2642, respectively. Relocate Russian Strela Grapple Fixture to FGB EFGF, and remove US Grapple Fixture Adapter from PMA-1.
062	-	FLIGHT 7P_AR	ISS with 7P Progress M1-8 after docking to Zvezda Service Module aft.
072	-	STAGE 8A_AR	ISS with STS-110 Orbiter after rendezvous [fully loaded]. Orbiter Docked to PMA-2 tail nadir.
073	-	STAGE 8A_INT1	ISS with STS-110 Orbiter after SSRMS berths ITS S0, with Mobile Transporter (MT), to LCA on United States Laboratory (Destiny Lab) zenith. Install the forward and aft S0 truss MTS struts to the Destiny Lab. (Note: Fwd and Aft struts are installed on two separate EVAs)
074	-	STAGE 8A_BS	ISS with STS-110 Orbiter before separation. Install and deploy the Lab starboard and port avionics umbilical trays and connect umbilicals. Deploy S0-to-Lab aft trays and connect umbilicals. Install Airlock spur between the Airlock and S0 truss. Deploy Extravehicular-Charged Particle Detection System (EV-CPDS). Install Crew and Equipment Translation Assembly (CETA) light on Destiny Lab. Install Node 1 port CETA lights. Install S0-to-Node 1 tray and connect umbilicals. Install starboard and port CETA-to-MT energy absorber. Install S0 PWP and relocate MT from launch position to worksite #4. Remove and stow keel pins. Deploy Node 1 swing arm.
075	-	STAGE 8A_AS	ISS after STS-110 Orbiter separation.
068e	-	FLIGHT 3S_AS1	ISS after 3S Soyuz TM-33 separation from FGB nadir port.
068h	-	FLIGHT 3S_AR2	ISS with 3S Soyuz TM-33 after docking to DC 1 nadir port.
085	-	FLIGHT 4S_AR	ISS with 4S Soyuz TM-34 after docking to FGB nadir port.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
086	-	FLIGHT 3S_AS2	ISS after 3S Soyuz TM-33 separation from DC1 nadir port.
078	-	STAGE UF2_AR	ISS with STS-111 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA-2 tail nadir.
079	-	STAGE UF2_INT1	ISS with STS-111 Orbiter after fully loaded MPLM berthed to Unity Node 1 nadir.
108	-	STAGE UF2_INT2	ISS with STS-111 Orbiter after PDGF is installed on P6 truss and Service Module Debris Panel (SMDP) kit stowed on PMA-1 (WIF 02-04).
080	-	STAGE UF2_INT3	ISS with STS-111 Orbiter after MBS installed on the MT and the MBS Latching End Effector (LEE) and MBS camera deployed. MPLM is prepared for return, but still attached to Node 1.
081	-	STAGE UF2_BS	ISS with STS-111 Orbiter before separation. Return MPLM returned to Orbiter bay. EVA activities completed.
082	-	STAGE UF2_AS	ISS Stage UF2 after separation of STS-111 Orbiter.
070	-	FLIGHT 7P_AS	ISS after separation of 7P Progress M1-8 from Zvezda Service Module aft, after unloading of propellant and dry cargo and loading waste. Prior to this configurstion, install SMDP panels on the Service Module. Install 2 Ham Radio Antennas (WA 1 and WA2) on the Service Module. Remove panel 1 of MPAC/SEEDs experiment and reconfigure panles 2 and 3 on the support structure. Relocate SSRMS from US Lab to MBS PDGF #1.
071	-	FLIGHT 8P_AR	ISS with 8P Progress M-46 after docking to Zvezda Service Module aft. Progress vehicle clocked at 45 degrees.
076	-	FLIGHT 8P_AS	ISS after 8P Progress M-46 separation from Zvezda Service Module aft, after unloading of propellant and dry cargo and loading of waste.
077	-	FLIGHT 9P_AR	ISS with 9P Progress M1-9 after docking to Zvezda Service Module aft. Progress vehicle clocked at 45 degrees.
087	-	STAGE 9A_AR	ISS with STS-112 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA-2 tail nadir. Prior to this configuration, relocate MT to worksite # 4.
088	-	STAGE 9A_INT1	ISS with STS-112 Orbiter after ITS Starboard 1 (S1) berthed to S0.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
089	-	STAGE 9A_BS	ISS with STS-112 Orbiter before separation. Install external cameras and stanchions on Destiny Lab [port 13] and S1 truss Outboard Lower [port 3]. Deploy S-band Antenna on S1. Deploy the External Active Thermal Control System (EATCS) S1 truss center radiator. Deploy CETA Cart 1 to starboard side of MT. Remove and stow S1 truss starboard and port keel pins. Transfer APFR and Tool Stanchion to CETA cart 1.
090	-	STAGE 9A_AS	ISS after STS-112 Orbiter separation.
100	-	FLIGHT 5S_AR	ISS with 5S Soyuz TMA-1 after docking to DC 1 nadir. Prior to this configuration, relocate SSRMS from MBS (PDGF 1) to MBS (PDGF 3)
101	-	FLIGHT 4S_AS	ISS after 4S Soyuz TM-34 separation from FGB nadir.
102	-	STAGE 11A_AR	ISS with STS-113 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA-2 tail nadir.
103	-	STAGE 11A_INT1	ISS with STS-113 Orbiter after ITS Port 1 (P1) berthed to S0.
104	-	STAGE 11A_BS	ISS with STS-113 Orbiter before separation. Install Wireless Video System [WVS] External Transceiver Assembly (WETA)s and stanchions on Node 1 [port 12] and P1 Outboard Upper [port 8]. Deploy and relocate CETA cart 2 to starboard side of MT. MT/CETA Cart configuration is CETA-CETA-MT. Remove and stow P1 truss starboard and port keel pins.
105	-	STAGE 11A_AS	ISS after STS-113 Orbiter separation.
083	-	FLIGHT 9P_AS	ISS after 9P Progress M1-9 separation from Zvezda Service Module aft, following unloading of propellant and dry cargo and loading of waste. Prior to this configuration, deploy EATCS P1 truss central radiator. Install ETSD #1 (port) and IAPFR on CETA cart 1. Deploy and install CETA light stanchion and one lights on S1 truss and deploy UHF antenna. Relocate the MT to worksite #4 and transfer the SSRMS from the MBS to US Lab.
084	-	FLIGHT 10P_AR	ISS with 10P Progress M-47 after docking to Zvezda Service Module aft. Progress vehicle clocked 45 degrees.
091	-	STAGE ULF1_AR	ISS with STS-114 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA-2 tail nadir.
092	-	STAGE ULF1_INT1	ISS with STS-114 Orbiter after ESP-2 with ORUs installed on A/L forward trunnions.
109	-	STAGE ULF1_INT2	ISS with STS-114 Orbiter after Fully loaded MPLM berthed to Node 1 nadir.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
093	-	STAGE ULF1_INT3	ISS with STS-114 Orbiter after MPLM is prepared for return, but still attached to Node 1. Change out failed CGM. Replace External Attached Payload 1 A and B (MISSE) on A/L nadir center HPGT (#2) and crew lock with External Attached Payload 1 C and D (MISSE). Install VSSA stanchions on S1 truss outboard upper [port 2] and P1 truss outboard lower [port 9]. Install Field Plasma Measurement Unit (FPMU)on S1 truss outboard upper [port 2]. Install ETVCG on P1 truss outboard lower stanchion [port 9].
094	-	STAGE ULF1_BS	ISS with STS-114 Orbiter before separation. Return MPLM to Orbiter bay. Remove ESP-2 FRGF and return it in starboard TSA.
095	-	STAGE ULF1_AS	ISS after STS-114 separation.
114	-	FLIGHT 6S_AR	ISS with 6S Soyuz TMA-2 vehicle after docking to FGB nadir. Soyuz vehicle clocked 45 degrees. Prior to this configuration, relocate the SSRMS from US Lab to the MBS PDGF #3 and #4. Relocate MT from worksite #4 to worksite #7.
115	-	FLIGHT 5S_AS	ISS after 5S Soyuz TMA-1 separation from Pirs DC 1 nadir port.
097	-	FLIGHT 11P_AR	ISS with 11P Progress M1-10 after docking to DC1 nadir docking port.
110	-	STAGE 12A_AR	ISS with STS-115 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA-2 tail nadir.
111	-	STAGE 12A_INT1	ISS with STS-115 Orbiter after ITS Port 3 and 4 (P3 and P4) are attached to P1 truss.
112	-	STAGE 12A_BS	ISS with STS-115 Orbiter before separation. Rotate P4 truss keel pin. Install the VSSA stanchion on P3 truss [port 10]. Remove and stow P3 truss keel pin. Rotate Solar Alpha Rotary Joint (SARJ) 180 deg to 0 deg position [launch and install position at 180 deg]. Lock the P4 truss SARJ and deploy Channels 4A and 2A Solar Arrays. Deploy P4 truss Photovoltaic (PV) radiator. Move CETA cart to port side of MT. MT/CETA cart configuration is CETA-MT-CETA. Install the ETVCG and VSSA stanchion on P1 inboard lower [port 7]. Translate MT from worksite #7 to worksite #4.
113	-	STAGE 12A_AS	ISS after STS-115 separation.
096	-	FLIGHT 10P_AS	ISS after 10P Progress M-47 separation from Zvezda Service Module aft.
099	-	FLIGHT 12P_AR	ISS with 12P Progress M-48 after docking to Service Module aft. Progress vehicle is clocked 45 degrees.
116	-	STAGE 12A.1_AR	ISS with STS-116 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA-2 tail nadir. Prior to this configuration, relocate MT from worksite #4 to worksite #8.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
117	-	STAGE 12A.1_INT1	ISS with STS-116 Orbiter after ITS Port 5 (P5) berthed to P4 truss segment.
118	-	STAGE 12A.1_BS	ISS with STS-116 Orbiter before separation. Relocate the Photovoltaic Removable Grapple Fixture (PVRGF) to the MBS Latching End Effector (LEE) from P5. Deactivate and retract P6 truss Channel 4B Port Solar Array. Remove fixed Grapple Bar (GB) from SHOSS and attach to starboard ATA. Transfer the Pump Module, MBSU, SHOSS-ED (DDCU Cold Plate (CP), Main Bus Switching Unit (MBSU) CP and adjustable GB) to ESP-2. Relocate CETA cart to port side. MT/CETA cart configuration is MT-CETA-CETA. Connect P4 truss channel 4A SA power to ISS MBSU and activate first EATCS loop. Unlock P4 truss SARJ once channel 4B retracted. Connect P4 truss channel 2A power to ISS MBSU and activate second EATCS loop. Relocate MT to worksite #4. Transfer PFCS from ESP-1 to ICC. Relocate SSRMS to PDGF #2 and #3.
119	-	STAGE 12A.1_AS	ISS after STS-116 separation.
122	-	STAGE 13A_AR	ISS with STS-117 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA-2 tail nadir. Prior to this configuration, transfer P5 PVRGF from MBS LEE to P6 EEATCS aft radiator. Relocate the SSRMS to MBS PDGF #1 and #2 and translate the MT to worksite #2. Retract and stow P6 truss starboard and aft EEATCS radiators. Remove MPAC/SEEDS experiment cartridge #2 from Service Module and move cartridge #3 to the center location on the experiment platform.
123	-	STAGE 13A_INT1	ISS with STS-117 Orbiter after ITS Starboard Trusses 3 and 4 (S3 and S4) are attached to S1 truss.
124	-	STAGE 13A_BS	ISS with STS-117 Orbiter before separation. Rotate S4 truss keel pin. Relocate P6 truss EEATCS aft radiator to S4 truss. Move P5 PVRGF from S4 truss PVTCS radiator to MBS LEE. Retract P6 truss starboard Solar Array 2B. Deploy S4 truss radiator. Deploy and activate Channel 1A and 3A Solar Arrays and connect to MBSUs. Unlock the S4 truss SARJ. Remove and stow S3 truss keel pin. Relocate MT to worksite #4. Move PVRGF from MBS LEE to P6 starboard radiator.
125	-	STAGE 13A_AS	ISS after STS-117 separation.
120	-	FLIGHT 12P_AS	ISS after 12P Progress M-48 separation from Zvezda Service Module aft. Prior to this configuration, retract starboard and port FGB solar arrays.
133	-	FLIGHT 7S_AR1	ISS with 7 Soyuz TMA-3 after docking to Zvezda Service Module aft. Soyuz clocked at 45 degrees.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
134	-	FLIGHT 6S_AS	ISS after 6 Soyuz separation from FGB nadir port.
133e	-	FLIGHT 7S_AS1	ISS after 7 Soyuz undocks from Zvezda Service Module aft.
133h	-	FLIGHT 7S_AR2	ISS with 7 Soyuz after docking to FGB nadir docking port. Soyuz clocked at 45 degrees.
098	-	FLIGHT 11P_AS	ISS after 11P Progress M1-10 separation from DC1.
135	-	FLIGHT 13P_AR	ISS with 13P Progress M1-10 after docking to DC1.
126	-	STAGE 13A.1_AR	ISS with STS-118 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA-2 tail nadir.
127	-	STAGE 13A.1_INT1	ISS with STS-118 Orbiter after SSRMS is relocated to PDGF #1 and #2. SRMS unberth S5 from the PLB and hands it off to the SSRMS. Translate MT, with SSRMS carrying S5, from worksite #4 to worksite #1. Lock S4 truss SARJ and beta Gimbals. SSRMS maneuvers S5 and berth it to S3/S4. Unlock S4 truss SARJ and beta gimbals.
128	-	STAGE 13A.1_INT2	ISS with STS-118 after S5 truss PVRGF was relocated from S5 truss launch configuration to S5 truss keel. Relocate the SSRMS to PDGF #2 and #3. Translate the MT from worksite #1 to worksite # 3. Transfer the EAS from the P6 truss to the ICC. Relocate SASA from P6 to P1 and the BSP and Transponder from Z1 to P1.
131	-	STAGE 13A.1_BS	ISS with STS-118 Orbiter before separation. Relocate the SSRMS to PDGF #3 and #4. Transfer BCDU from ICC to ESP-2 and VSSA FSE from ESP-2 to ICC. Replace Node 1 port Early COM plate with a window. Translate the MT to worksite #4.
132	-	STAGE 13A.1_AS	ISS after STS-118 separation.
136	-	FLIGHT 14P_AR	ISS with 14P Progress M-48 after docking to Service Module aft. Progress is clocked 45 degrees. Prior to this configuration, Relocate PMA 3 from Node 1 port to Node 1 nadir. Retract P6 truss PV radiator, currently in the forward position, to its launch configuration. Remove FPP from P6 and place it inside the ISS. Relocate CETA cart to starboard side. MT/CETA cart configuration is CETA-MT-CETA. Relocate SSRMS to PDGF #2 and #3.
137	-	STAGE 15A_AR	ISS with STS-119 Orbiter after rendezvous [fully loaded]. Orbiter docked to PMA-2 tail nadir. Prior to this configuration, relocate the SSRMS to PDGF #1 and #2 and translate MT to worksite #1.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
138	-	STAGE 15A_INT1	ISS with STS-119 Orbiter after S4 truss SARJ is locked. SRMS unberth S6 from the PLB and hands it off to the SSRMS. Install S6 truss to S5 truss. Unlock S4 truss SARJ. Deploy S6 truss PV radiator. Deploy and activate S6 truss channels 3B and 1B SA.
139	-	STAGE 15A_INT2	ISS with STS-119 after MT is translated from worksite #1 to worksite #6. Relocate SSRMS to PDGF #3. Detach P6 truss from Z1 truss, and place in thermal attitude hold with SSRMS in overnight parking position. A negative hold position for P6 is assumed based on a negative ISS beta orbit.
140	-	STAGE 15A_INT3	ISS with STS-119 after P4 truss SARJ is locked. SSRMS hands off P6 truss to SRMS. Translate MT from worksite #6 to worksite #8. SRMS hands off P6 truss to SSRMS. Attach P6 truss to P5 truss outboard. Unlock P4 truss SARJ. Relocate SSRMS to PDGF #3 and #4.
141	-	STAGE 15A_BS	ISS with STS-119 Orbiter before separation. Relock P4 truss SARJ. Deploy P6 truss PV nadir radiator, currently in the nadir position. Deploy and activate P6 truss channel 4B and 2B Solar Arrays. Unlock P4 truss SARJ. Relocate MT to worksite #4.
142	-	STAGE 15A_AS	ISS after STS-119 separation.
143	-	FLIGHT 13P_AS	ISS after 13P Progress M-38 separation from DC1. Prior to this configuration, remove the FPMU from S1 truss outboard upper stanchion [port 2] and place inside US Lab. Move stanchion to S3 truss aft [port 1] and install WETA 4.
144	-	FLIGHT 15P_AR	ISS with 15P Progress M-48 after docking to DC1.
145	-	STAGE 10A_AR	ISS with STS-124 Orbiter after rendezvous. Orbiter docked to PMA-2 tail nadir. Prior to this configuration, Relocate the SSRMS from the MBS to US Lab PDGF.
146	-	STAGE 10A_INT1	ISS with STS-124 after Node 2 removed from the Orbiter bay and installed on Node 1 port CBM (keel pin aft nadir).
147	-	STAGE 10A_BS	ISS with STS-124 Orbiter before separation. Install keel pin and trunnion covers. Install PDGF on Node 2 and perform middeck trensfer.
148	-	STAGE 10A_AS	ISS after STS-124 Orbiter after separation. Node 2 still on Node 1 port CBM and PMA 2 on US Lab.
149	-	STAGE 10A_Stage1	ISS after PMA 2 relocated from US Lab forward to Node 2 CBM while Node 2 is still attached to Node 1 port CBM.

Table 4.0-1 Configuration List

Configuration Number	Revision Q Supplemental Step Number	Configuration / Step Name	Description
150	001	STAGE 10A_AS2	ISS after Node 2, with PMA 2 attached to it, was relocted from Node 1 port CBM to US Lab forward CBM. Port and starboard upper and lower EATCS radiators were deployed (keel pin port nadir).
	002	STAGE 1E_AS	ISS after Orbiter separation. Columbus module was installed on Node 2 starboard CBM. Two payloads were deployed on the Columbus module on this flight. Prior to this flight, the Automated Transfer Vehicle (ATV) visited the ISS docking to Service Module aft docking port.
	003	STAGE 1J_AS	ISS after Orbiter separation. Japanese Experiment Module (JEM) Pressurized Module (PM) was installed on Node 2 port CBM. JEM Pressurized Segment (PS) was also installed on this flight. Prior to this flight, Special Purpose Dexterous Manipulator (SPDM) was intalled on MBS-PDGF1, CETA starboard rails were installed on S4, S5 and S6. Alpha Magnetic Spectrometer (AMS) was deployed and installed on S3 upper inboard Payload Attachment System (PAS).
	004	STAGE 17A_AS	ISS after Orbiter separation. Node 3 was outfitted on this flight. Prior to this flight, Node 3 was installed on Node 1 nadir port, One JEM rack was delivered to the ISS, Payloads 3 and 4 were deployed on Columbus module. Multi-Purpose Module (MTsM) was installed on FGB nadir port and PMA 3 was relocated to Node 3 nadir CBM.
	005	STAGE 2J/A_AS	ISS after Orbiter separation. On this flight, JEM Exposed Facility (EF) and Experiment Logistics Module (ELM) Exposed Section (ES) were delivered to the ISS. Prior to this flight, the Centrifuge Accomodation Module (CAM) was installed and deployed on Node 2 zenith CBM.
	006	STAGE 14A_AS	ISS after Orbiter separation. On this flight, S3 express pallet was deployed on S3 outboard upper PAS. Cupola was also delivered to the ISS and installed on Node 1 port CBM. Prior to this flight, the H II Transfer Vehicle (HTV) visited the ISS docking to Node 2 nadir port.

5.0 MASS DATA INTEGRATION

Mass properties input data was supplied to the SEMDA Laboratory by the Lockheed Martin RAI Team. Mass properties input data was integrated from a variety of sources using the MPVSET. Mass properties were entered into the *I-DEAS Computer Aided Design (CAD)* model when available. If only mass was provided, *I-DEAS* calculated mass properties assuming a uniform density.

5.1 MASS PROPERTIES SOURCES

Lockheed Martin (LM) RAI team and SEMDA team used a variety of sources to generate the mass properties input data for the *I-DEAS CAD* Model. The VIPeR Resource Management Mass Manifest spreadsheet provided equipment lists and launch weight tables consistent with Vehicle Management *Data Book* inputs. Cargo Element Mass Properties spreadsheets supplied mass properties from United States manufacturers and integrators. RSC-E supplied Progress and Soyuz vehicle mass properties. Space Shuttle data for Assembly and Logistics flights were obtained from SODBs. Refer to Section 2.1 for details.

5.2 MASSES OF FREE FLYING CONFIGURATIONS

Mass Summary of Free Flying Configurations, Table 5.2-1, provides data for ISS alone configurations with delta mass changes. Table 5.2-1 provides step number, stage name and corresponding ISS components with associated masses manifested. ISS configurations with zero mass changes are omitted. Table 5.2-1 provides the following:

Step Number	Sequential number of the flight.
Stage Name Number	Stage name or space agency launch designation or special designation for a significant ISS geometry modification
Element Description	Manifested components added to the ISS [or those orbiting items returning to Earth]
Mass [lb]	Mass of payload components in pounds
Mass [kg]	Mass of payload components in kilograms
Stage Total [kg]	Net total mass of payloads to or from orbit by a configuration

Section 4.0 provides additional nomenclature explanations. Multiple ISS pressurized modules and other components change mass during ISS assembly. The repeated appearance of a component named in Table 5.2-1 addresses this effect. A suffix designates flight or range of flights for which the indicated mass applies. The Stage Total and Station Total column entries include only the net mass delta added to the ISS.

Table 5.2-1 Mass Summary of Free Flying Configurations

Step Name Number	Component Description	Mass [lb]	Mass [kg]	Stage Total [kg]	Station Total [kg]
Stage 10A	U.S. Laboratory	57467	26067		
001	Progress 14P (@ SM Aft)	15288	6934		
	Progress 15P (@ DC-1)	15288	6934		
	Soyuz 7S (@ FGB Nadir)	14870	6745		
	Node 1	24875	11283		
	Node 2	30949	14038		
	Airlock	20778	9425		
	FGB (including fuel)	49371	22394		
	Service Module	51280	23260		
	Docking Compartment (DC-1)	6934	3145		
	ITS Z1 Core	18988	8613		
	ITS S0 Core	24943	11314		
	ITS S1 Core	15810	7171		
	ITS P1 Core	15774	7155		
	ITS S3 Core	4709	2136		
	ITS P3 Core	4771	2164		
	ITS S4 Core	17726	8041		
	ITS P4 Core	17290	7843		
	ITS S5 Core	3969	1801		
	ITS P5 Core	3760	1705		
	ITS S6 Core	22447	10182		
	ITS P6 Core	25483	11559		
	PMA-1	3387	1536		
	PMA-2	2565	1164		
	PMA-3	2575	1168		
	SM PV Array - Port	1279	580		
	SM PV Array - Starboard	1279	580		
	FGB PV Array - Port	551	250		
	FGB PV Array - Starboard	551	250		
	P6 POA Solar Array (Deployed)	2342	1062		
	P6 POF Solar Array (Deployed)	2335	1059		
	S6 SOA Solar Array (Deployed)	2341	1062		
	S6 SOF Solar Array (Deployed)	2341	1062		
	P4 PIA Solar Array (Deployed)	2368	1074		
	P4 PIF Solar Array (Deployed)	2368	1074		
	S4 SIA Solar Array (Deployed)	2368	1074		
	S4 SIF Solar Array (Deployed)	2368	1074		
	P6 Radiator (Deployed)	1612	731		
	S4 Radiator (Deployed)	1640	744		
	S6 Radiator (Deployed)	1640	744		
	P6 Forward Radiator (Stowed)	1640	744		
	S3 Rotor	980	445		
	S3 UCLA (4)	1311	595		

Table 5.2-1 Mass Summary of Free Flying Configurations

Step Name Number	Component Description	Mass [lb]	Mass [kg]	Stage Total [kg]	Station Total [kg]
	S3 Stator	1960	889		
	S3 Rotor Bulkhead	531	241		
	P3 UCLA (2)	677	307		
	P3 Stator	1960	889		
	P3 Rotor	980	445		
	P3 Rotor Bulkhead	522	237		
	P4 Radiator (Deployed)	1612	731		
	P4 Beta Gimbal	1840	834		
	PFCU (2) on P4	488	221		
	S4 Beta Gimbal	1839	834		
	S6 Beta Gimbal	1876	851		
	P5 PVRGF	231	105		
	S5 PVRGF	231	105		
	S-Band Antenna (on ITS Z1)	227	103		
	UHF Antenna on LAB	94	43		
	ESP-2 Core	5494	2492		
	Pump Module on ESP-2	1448	657		
	BCDU on ESP-2	561	255		
	MBSU on ESP-2	546	248		
	SHOSS-ED on ESP-2	1007	457		
	DCSU on ESP-1 (US LAB)	476	216		
	PDGF on Node 2	73	33		
	SSRMS (on LAB)	3311	1502		
	Mobile Servicing Center	6290	2853		
	EATCS Radiator deployed on S1	11454	5196		
	EATCS Radiator deployed on P1	11454	5196	253917	253917
Stage 1E	US Laboratory	52856	23975		
002	Columbus Orbital Facility (COF)	35516	16110		
	SOLAR on APM	740	336		
	EuTUF on APM	800	363	14717	268634
Stage 1J	ITS P1	15851	7190		
003	Node 2	31026	14073		
	US Laboratory	55976	25390		
	Columbus Orbital Facility (COF)	33867	15362		
	Japanese Experiment Module JEM-PM	45594	20681		
	Japanese Experiment Module JEM-PS	10606	4811		
	AMS on ITS S3	14809	6717		
	CETA Rail (S4)	871	395		
	CETA Rail (S5)	577	262		
	CETA Rail (S6)	2013	913		
	SPDM	3590	1628	36144	304778

Table 5.2-1 Mass Summary of Free Flying Configurations

Step Name Number	Component Description	Mass [lb]	Mass [kg]	Stage Total [kg]	Station Total [kg]
Stage 17A	Soyuz TM Special (@ MTsM)	14870	6745		
004	MTsM	39165	17765		
	Japanese Experiment Module JEM-PM	46802	21229		
	Japanese Experiment Module JEM-PS	10677	4843		
	PMA-3	2575	1168		
	US Laboratory	58018	26316		
	Node 2	33133	15029		
	Node 3	41520	18833		
	Columbus Orbital Facility (COF) w/ add'l P/L's 3 & 4	35389	16052	39750	344528
Stage 2J/A	Node 2	33177	15049		
005	US Laboratory	55153	25017		
	CAM	30957	14042		
	Japanese Experiment Module JEM-PM	46913	21280		
	Japanese Experiment Module JEM-EF	10606	4811		
	Japanese Experiment Module JEM-EL	2990	1356	18980	363508
Stage 14A	Soyuz (@ DC-1)	14870	6745		
006	Japanese Experiment Module JEM-EF	13392	6074		
	US Laboratory	55936	25372		
	Cupola	3839	1741		
	Express Pallet 1 on ITS S3 Outboard Upper PAS	6766	3069	6240	369748

5.3 ORBITER MASS

The primary source for Orbiter mass properties was the SODB. Generic Orbiter Mass Properties, Table 5.3-1, provides mass properties assessments for Space Shuttle vehicle intervals which do not have SODB information at the time of data collection for this Data Book. The table was created from the SODB Sequential mass properties for Stage (12A) STS-115 [product number prop02, dated 9/25/02] to construct the generic Endeavor orbiter. Original values are shown in the “SODB Total Orbiter” rows. The deducted payloads are shown in the “Payload Subtract” rows. The resultant mass and mass properties, which are similar to the shuttle without any payload, are shown in the “Generic Orbiter” rows. The Endeavour generic Orbiter was utilized for the 10A mission. The mission specific payloads for each shuttle flight were included to develop the Orbiter totals for these missions.

NOTE: Products of inertia are positive integrals in Tables 5.3-1. Orbiter mass property inputs are reported in the OSRS for this table. Section 3.0 contains detailed coordinate system descriptions. Refer to Table 6.3-1 for Orbiter to ISS attach points.

Table 5.3-1 Generic Orbiter Mass Properties

Units [English] [Metric]	Mass [lb] [kg]	CMx [in] [m]	CMy [in] [m]	CMz [in] [m]	Ixx [slug*ft2] [kg*m2]	Iyy [slug*ft2] [kg*m2]	Izz [slug*ft2] [kg*m2]	Ixy [slug*ft2] [kg*m2]	Ixz [slug*ft2] [kg*m2]	Iyz [slug*ft2] [kg*m2]
***** Generic Orbiter for Endeavour Flights; based off Stage 12A Orbiter - Used for Flights 10A										
Endeavour Orbiter After Rendezvous - STS-115 (12A) Prop 02, 9/25/02, ISS DOCKING										
Generic Orbiter OSRS [English]	244764.2	1090.24	-0.64	375.73	945532	7472793	7783613	18202	242405	-1090
Payload Subtract [English]	-35053.2	1054.64	-1.72	401.93	20511	127100	127978	25	-1989	-383
Generic Orbiter OSRS [English]	209711.0	1096.19	-0.46	371.35	959974	7582654	7900400	17889	248645	-1224
Generic Orbiter OSRS [Metric]	95123.3	27.843	-0.012	9.432	1301550	10280698	10711505	24255	337118	-1660
Generic Orbiter SSACS [Metric]	95123.3	10.954	-0.012	16.919	10364474	9936050	1245932	622	-342512	24186
Endeavour Orbiter Before Separation - STS-115 (12A) Prop 02, 9/25/02, ISS UNDOCKING										
Generic Orbiter OSRS [English]	208309.5	1096.82	-0.29	371.73	915708	7320285	7635783	17484	250839	-973
Payload Subtract [English]	0.0	0.00	0.00	0.00	0	0	0	0	0	0
Generic Orbiter OSRS [English]	208309.5	1096.82	-0.29	371.73	915708	7320285	7635783	17484	250839	-973
Generic Orbiter OSRS [Metric]	94487.6	27.859	-0.007	9.442	1241534	9924974	10352731	23705	340093	-1319
Generic Orbiter SSACS [Metric]	94487.6	10.946	-0.007	16.935	10352731	9924974	1241534	1319	-340093	23705

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6.0 GEOMETRY DATA INTEGRATION

The ISS and integrated Space Shuttle geometry inputs were collected, modeled, and organized to correspond with mass and assembly inputs. The Configuration List, Table 4.0-1, was used as a reference to build all mass properties and geometric models. After mass and assembly inputs were integrated into SEMDA Lab mass spreadsheets, information from these spreadsheets were applied to develop and update geometry model components and assemblies.

6.1 ISS GEOMETRY

The geometric representation for ISS components making up the assembly flight configurations is approximate. NASA modules were based on electronic files received from the Boeing-PIT. The CSA electronic geometry files, transferred through Boeing, were used to model Canadian robotics equipment. Russian geometry baselines and updates were obtained from Russian engineers via the TIM and regular teleconferences. Russian engineers provided Zarya FGB, Service Module, and Pirs DC 1 data books, drawings and electronic files. See entries in the 2.1 Applicable Documents section for further details.

Information in this document was based on solid geometry models constructed with the SDRC *I-DEAS Master Series* modeling package. Configuration models were defined using the data associated with the Table 4.0-1 Configuration List. ISS geometry was modeled in the SSACS.

6.2 ORBITER GEOMETRY

The geometric representation of the Space Shuttle and associated integrated payload components is approximate. Space Shuttle geometry was created from dimensioned drawings and a computer model produced by Boeing for production of the Endeavour Orbiter Vehicle (OV) 105. Additional information sources include the National Space Transportation System (NSTS) SODB and amendments, and NSTS documents defining the ODS, Androgynous Peripheral Assembly System (APAS), and ISS PMA mating interfaces. Figure 3.3-1 and Section 3.3 provide basic Orbiter dimensions and descriptions of the various positions of the ODS. The outer surfaces of the Space Shuttle body, wings, and vertical tail were based on a detailed finite element model. The resulting model geometry was verified with a three-dimensional electronic wire frame geometry model from Boeing-North American, at Huntington Beach, California. Orbiter base mass properties were assigned to the model as described in Section 5.3. Data inputs were based on the OSRS, as defined in Section 3.3.

On-orbit analysis data outputs in this document, including those related to Orbiter vehicles, are reported in the SSACS frame as described in Section 3.2. On-orbit output data sets are derived from solid geometry models constructed using *I-DEAS Master Series* software package.

6.3 ORBITER TO ISS ATTACH POINTS

The Table 6.3-1 lists the Orbiter to ISS docking reference point positions in the SSACS. This table also supplies the orientation of the Orbiter, the ISS docking module to which the Orbiter was docked, and the direction of the Orbiter tail.

Table 6.3-1 Orbiter to ISS Attach Points

STAGE	ATTACH POINTS		PMA 2			PMA 3		
			x	y	z	x	y	z
10A-1J	Orbiter docks to PMA 2 attached to Node 2 forward CBM [clocked for Orbiter tail nadir docking.]	mm	15427	10	5573	-3751	-1	9234
	PMA 3 is located at Unity Node 1 nadir docking port [clocked for Orbiter tail forward docking].	in	607.4	0.4	219.4	-147.7	0	363.5
17A-14A	Orbiter docks to PMA 2 attached to Node 2 forward CBM [clocked for Orbiter tail nadir docking.]	mm	15427	10	5573	-3758	-4	15964
	PMA 3 is located at Node 3 nadir docking port.	in	607.4	0.4	219.4	-148	0	628.5

6.4 ELEMENT INTERFACES LOCATION

Table 6.4-1 lists the modular interface points in SSACS reference frame.

Table 6.4-1 Element Interface Points

Description	No.	X [mm]	Y [mm]	Z [mm]	Mode
PMA 3 [Unity Node 1 nadir]					
CBM [zenith]	1	-4462	-1	6848	Passive
APAS [nadir]	2	-3751	-1	9234	Passive
PMA 3 [Unity Node 1 port]					
CBM [starboard]	1	-4462	-1997	4849	Passive
APAS [port]	2	-4460	-4386	5556	Passive
ITS Z1					
CBM [nadir]	1	-4463	0	2857	Passive
CBM [forward]	2	-3271	0	475	Active
Zvezda Service Module					
Hybrid [forward]	1	-22579	-6	4142	Passive [cone]
Probe and Cone [aft]	2	-35691	-6	4142	Passive [cone]
Hybrid [zenith]	3	-23703	-6	3018	Passive [cone]
Hybrid [nadir]	4	-23703	-6	5266	Passive [cone]
PMA 2 [Destiny Lab forward]					
APAS [forward]	1	8692	7	5565	Passive
CBM [aft, includes seal]	2	6302	9	4854	Passive
PMA 2 [Node 2/Node 1 port]					
APAS [forward]	1	-4454	-11126	5559	Passive
CBM [aft, includes seal]	2	-4457	-8737	4852	Passive
PMA 2 [Node 2/Lab forward]					
APAS [forward]	1	15427	10	5573	Passive
CBM [aft, includes seal]	2	13038	8	4861	Passive
Unity Node 1					
CBM [forward]	1	-2435	-4	4851	Active
CBM [aft]	2	-7622	-4	4853	Active
CBM [zenith]	3	-4463	0	2857	Active
CBM [starboard]	4	-4463	1992	4852	Active
CBM [nadir]	5	-4463	-5	6846	Active
CBM [port]	6	-4463	-1997	4849	Active
PMA 1 on Unity [aft CBM]					
CBM [forward]	1	-7622	-4	4853	Passive
APAS [aft]	2	-10016	-6	4142	Active
Zarya FGB					
APAS [forward]	1	-10016	-6	4142	Passive
Hybrid [aft]	2	-22579	-6	4142	Active [probe]
Probe and Cone [nadir]	3	-11134	-6	5284	Passive [cone]
Destiny Lab Module [Unity forward]					
CBM [forward]	1	6302	6	4854	Active
CBM [aft]	2	-2435	-3	4851	Passive

Table 6.4-1 Element Interface Points

Description	No.	X [mm]	Y [mm]	Z [mm]	Mode
US Airlock [on Unity Node 1 starboard]					
EVA Hatch	1	-4476	6452	5922	-
CBM [port]	2	-4464	1992	4852	Passive
Pirs DC 1 [on Zvezda nadir]					
Hybrid [zenith]	1	-23703	-6	5266	Probe
Probe and Cone [nadir]	2	-23703	-6	9315	Cone
Node 2 [Node 1 port]					
CBM [forward]	1	-2459	-6632	4857	Active
CBM [aft]	2	-6459	-6635	4844	Active
CBM [zenith]	3	-4453	-6634	2851	Active
CBM [starboard]	4	-4462	-2008	4849	Active
CBM [nadir]	5	-4465	-6633	6850	Active
CBM [port]	6	-4467	-8737	4852	Active
Node 2 [Lab forward]					
CBM [forward]	1	13038	8	4861	Active
CBM [aft]	2	6302	7	4854	Active
CBM [zenith]	3	10937	11	2858	Active
CBM [starboard]	4	10934	2007	4861	Active
CBM [nadir]	5	10933	4	6858	Active
CBM [port]	6	10935	-1992	4854	Active
Node 3 [Node 1 nadir]					
CBM [forward]	1	-2467	-2	11476	Active
CBM [aft]	2	-6467	-9	11472	Active
CBM [zenith]	3	-4463	-5	6846	Active
CBM [starboard]	4	-4470	1995	11473	Active
CBM [nadir]	5	-4470	-4	13577	Active
CBM [port]	6	-4463	-2005	11474	Active
PMA 3 [Node 3 nadir]					
CBM [zenith]	1	-4470	-4	13577	Passive
APAS [nadir]	2	-3758	-4	15964	Passive

7.0 CONFIGURATION DATA

Section 7 provides illustrations and descriptions of ISS configuration changes including , module movements, truss structure movements.

Section 7.0 details types of data sets supplied for each configuration.

This section of the *Data Book* contains 6 Steps that describe the assembly sequence of the ISS from the second Post-Stage 10A to Stage 14A. The following paragraphs describe features of each Configuration section. Configuration sections consist of these data categories:

- Section Title
- Configuration Description
- Orbiter Attach Point Location
- Element Interfaces
- Element Properties

7.1 SECTION TITLE

The Section Title lists a step number on the first line and a stage or flight description on the second line. The step number is the sequential order of events specifically for the current assembly sequence *Data Book*. Table 4.0-1 provides a list of step number for each configuration. Section 4.0 provides information on nomenclature used in the stage and flight designations.

7.2 CONFIGURATION DESCRIPTION

The information provided in bullet format at the beginning of each configuration summaries the activities that occur. This information is derived from the Assembly Matrix, Assembly Sequence, and Assembly Overviews. Major configuration events can include docking and undocking, relocation of modules or other structures, EVAs, rack transfers, deployments and retractions, and ISS flight modes. This section includes descriptions of assumptions made in creation of geometry, mass properties, or assemblies representing ISS assembly operations.

As described in Section 3.2, the ISS flight mode is defined by the orientation of the SSACS frame Y-axis truss segment with respect to coordinates of the orbital LVLH coordinate system. Alignment of the SSACS Y-axis normal to the orbital plane [Y_A in the LVLH] defines the LVLH flight mode. When corrections for torque equilibrium attitude are insignificant, the Z-axis should point to the nadir and the X along the velocity vector.

7.3 ELEMENT INTERFACES

The Element Interface Table 6.4-1 indicates the location of each docking or berthing mechanism for all elements with this hardware after delivery to the ISS, or after repositioning once on orbit. Locations are given in millimeters in the SSACS frame.

These table values are updated whenever an element with docking or berthing mechanisms changes orientation or location.

7.4 ORBITER ATTACH POINT LOCATION

An Orbiter to ISS Attach Point Location Table provides the attached locations in inches and millimeters. This table includes the orientation of an Orbiter when docked. This information is available for all configurations on Table 6.3-1. A reference to this table appears only in After Rendezvous, Orbiter attached configuration sections.

7.5 ELEMENT PROPERTIES

The mass, center of mass, reference point, and inertia tensor are provided for every new major element which first arrives on orbit or any major element which is moved within the range shown in Section 1, Introduction, of this data book. When the element first arrives on orbit or undergoes a major geometry change a four-view illustration is shown. Note that the element illustrated may be rotated for clarity or for compatibility with the *SSP-30219 Coordinate System* document. The illustration provides overall dimensions of the element or group of elements in millimeters and inches. A reference point location is given in millimeters to both the SSACS and RSA Analysis Coordinate Systems. The mass properties are given when the element either (a) increases or decreases in mass, (b) moves to a new location on the ISS, or (c) changes configuration [such as mechanism deployment or retraction].

7.6 ILLUSTRATIONS AND CONFIGURATION MASS PROPERTIES

Each configuration is shown in an isometric illustration. The reverse side of this page shows a mass and aerodynamic properties for the configuration. The ISS properties data sets include mass, center of mass, inertia tensor, principal moments of inertia, centers of pressure, and projected areas.

Titles on these pages show the configuration number and a stage or flight description. Section 4.0 provides information on typical nomenclature used in the stage and flight designations.

The mass and aerodynamic properties data sets in this section contain these items:

Total Mass [lb.]	Mass of configurations in pounds
Total Mass [kg]	Mass of configuration in kilograms
Center of Mass:	
X	Distance along X-axis from origin in SSACS in feet and meters
Y	Distance along Y-axis from origin in SSACS in feet and meters
Z	Distance along Z-axis from origin in SSACS in feet and meters

Inertia Tensor:	
Ixx, Iyy, Izz	Moments of inertia with respect to SSACS frame axes in slug-ft^2 and kg-m^2 about the center of mass
Ixy, Iyz, Ixz	Products of inertia [negative integrals] with respect to SSACS frame axes in slug-ft^2 and kg-m^2 about the center of mass
Principal Moments Of Inertia:	
Ixx, Iyy, Izz	Principal moments of inertia with respect to SSACS frame axes in slug-ft^2 and kg-m^2 about the center of mass
Principal to Body Euler Angles:	
Roll, Pitch, Yaw	Angles required for rotating principal axes to body axes.
CP [Centers of Pressure]:	
CP_X	Distance in YZ plane from ISS center of mass in feet and meters.
CP_Y	Distance in XZ plane from ISS center of mass in feet and meters.
CP_Z	Distance in XY plane from ISS center of mass in feet and meters.
Projected Area:	
X-Axis	Configuration projected area in the YZ plane, in ft^2 and m^2
Y-Axis	Configuration projected area in the XZ plane, in ft^2 and m^2
Z-Axis	Configuration projected area in the XY plane, in ft^2 and m^2

7.8 AERODYNAMICS

Aerodynamic models for multi-body vehicles with articulating elements are based on reference areas and drag coefficients with provisions for shadowing effects and changing positions to the direction of flight and atmospheric flow.

This *Data Book* provides projected areas and centers of pressure allowing for shadowing. Drag coefficients are not provided.

Area properties are computed by *MODGEN* by two different procedures. Of the two procedures, the primary and most accurate method, represents each flight or assembly stage as an assembly of components. Each component is modeled in turn as an assembly of polygons approximating a more detailed geometry. Polygons are mapped onto a 101 X 101 expandable grid of rectangular cells for each axis in an orthogonal reference coordinate system.

Projected areas are determined by multiplying the total number of shadowed cells by the cell areas. For partially shadowed cells of the grid, if the center of the cell is shadowed, the cell is considered fully covered. CP is determined by the averaged cell location for each axis. CP vectors are transformed from the analysis coordinate system to the vehicle or body center of mass as shown in the tables of Sections 7.9 [Volume I] and 8.0 [Volume II] of the text. These data sets are available in a File Transfer Protocol (ftp) account as the “*.acp” family of files in the electronic access directories.

The secondary computation method for calculation of aerodynamic properties is based on modeling each component of the vehicle as a circular plate. For each reference axis, the cumulative effect of each geometric component is represented as a circular plate of corresponding projected area and moment arm for center of pressure. Results for model bodies and assembly configurations are available via electronic access in the “*.smry” family of files. In both methods, one coordinate of each center of pressure vector is undefined.

For example, in the CPx vector, the two methods described determine values for the Y and Z coordinates but not for X. This undefined coordinate is set to zero, that is, to the center of mass along the x-axis.

7.9 CONFIGURATION DATA SECTIONS

This portion of the document contains 6 configuration sections describing the ISS assembly sequence from Stage 10A After Separartion 2 to Stage 14A After Separation.

The Automated Transfer Vehicle (ATV) and the H II Transfer Vehicle (HTV) are not included in the configurations. Mass properties data of these two vehicles are found in Volume II as bodies 17 and 29 respectively.

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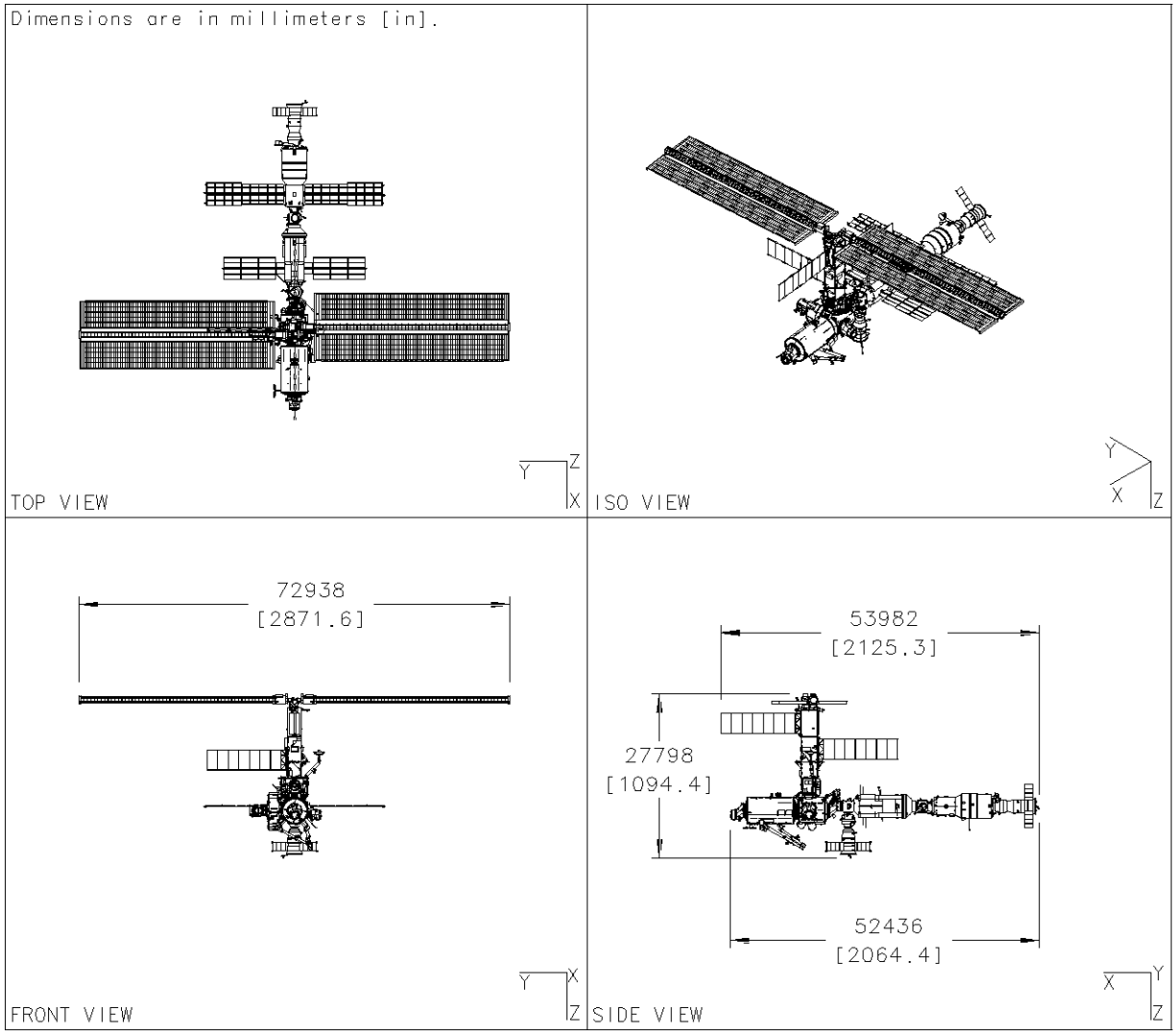
CONFIGURATION 053

Stage 7A - After Separation

ISS PHASE 2 COMPLETED



STEP 001

Stage 10A - After Separation 2

- Prior to Stage 10A – Stage 2:
  - Flight 1A American/Russian (A/R) delivered Zarya Control Module FGB in November 1998.
  - Flight 2A [STS-88] delivered Unity Node 1, PMA 1 and PMA 2 to mate with Zarya FGB Module in December 1998.
  - Stage 2A.1 [STS-96] delivered the first outfitting with Strela Operation Station and EVA Node bags that were placed on PMA 1 in May 1999 and Node 1 in June 1999.
  - Stage 2A.2A [STS-101] delivered second outfitting for Node 1 and Zarya FGB in May 2000.
  - Stage 1R [Russian] delivered Zvezda Service Module that docked to FGB in July 2000. Service Module provided early living quarters to ISS.
  - Flight 1P [Progress M1-3] docked to Zvezda Service Module aft docking port. Progress supplied propellant and consumables to ISS in August 2000.
  - Stage 2A.2B [STS-106] delivered a third set of logistics for the ISS in September 2000.
  - Stage 3A [STS-92] delivered Zenith 1 (Z1) Integrated Truss Assembly (ITA), PMA 3, Ku-band Antenna, and S-band Antenna in October 2000.
  - 1P [Progress M1-3] undocked from Zvezda Service Module aft docking port in October 2000.
  - Flight 2R [Soyuz 1S TM-31] docked to Zvezda Service Module aft docking port to deliver first ISS three-man crew in November 2000.
  - Flight 2P [Progress M1] docked to Zarya FGB nadir docking port with supplies to outfit the ISS in November 2000.
  - Flight 2P [Progress M1] separated from Zarya FGB nadir docking port after dry cargo, waste loading, and propellant transfer in December 2000.

STEP 001

Stage 10A - After Separation 2

- Stage 4A [STS-97] delivered ITS P6 to ISS. P6 solar arrays, forward and aft radiators, EVA Bag, and Plasma Probe deployed in December 2000.
- Flight 2P [Progress M1] docked to Zvezda Service Module aft docking port in December 2000.
- Flight 2P [Progress M1] undocked from Zvezda Service Module aft docking port in February 2001.
- Stage 5A [STS-98] delivered Destiny Laboratory Module to ISS. P6 starboard radiator deployed. Lab power, Power and Data Grapple Fixture (PDGF), and window shutter gearbox installed in February 2001.
- Flight 2R [Soyuz 1S TM-31] undocked from Zvezda Service Module aft docking port and redocked to Zarya FGB nadir docking port in February 2001.
- Flight 3P [Progress M-44] docked to Zvezda Service Module aft docking port in February 2001.
- Stage 5A.1 [STS-102] installed Leonardo Multi-Purpose Logistics Module (MPLM) and Lab Cradle Assembly. Second ISS crew arrived; first crew returned to Earth in March 2001.
- Flight 3P [Progress M-44] undocked from Zvezda Service Module aft docking port after unloading propellant and dry cargo and loading waste in April 2001.
- Flight 2R [Soyuz 1S TM-31] undocked from Zarya FGB nadir docking port and docked to Zvezda Service Module aft docking port in April 2001.
- Stage 6A [STS-100] delivered Spacelab Pallet, Ultra High Frequency (UHF) Antenna, the Space Station Remote Manipulator System (SSRMS) Lab PDGF, and Raffaello MPLM to ISS in April 2001.
- Flight 2S [Soyuz TM-32] docked to Zarya FGB nadir port in April 2001.

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Stage 10A - After Separation 2

- Flight 2R [Soyuz 1S TM-31] undocked for the third time from Zvezda Service Module aft docking port in May 2001
- Flight 4P [Progress M1-6] docked to Zvezda Service Module aft docking port in May 2001.
- Stage 7A [STS-104] delivered the Airlock module and four High Pressure Gas Assembly units in July 2001.
- Stage 7A.1 [STS-105] installed Donatello MPLM and delivered EAS, APFR, and (2) MISSEs. Third ISS crew arrived. Second ISS crew returned to Earth in August 2001.
- Flight 4P [Progress M1-6] undocked from Zvezda Service Module aft docking port after unloading propellant, dry cargo, and loading waste in August 2001.
- Flight 5P [Progress M-45] docked to Zvezda Service Module aft docking port and delivers the Russian experiment MPAC/SEEDs in August 2001.
- Stage 4R [Pirs DC 1] delivered the Pirs DC 1 and the second Strela Cargo Boom in September 2001. USI detached from Pirs DC 1. Soyuz docking target deployed on Pirs DC 1 nadir. MPAC/SEEDs deployed on Service Module.
- Flight 2S [Soyuz TM-32] undocked from Zarya FGB nadir docking port and docked to Pirs DC 1 nadir docking port in October 2001. EVA egress ladder and boom with antenna deployed on Pirs DC 1.
- Flight 3S [Soyuz TM-33] docked to Zarya FGB nadir docking port in October 2001.
- Flight 2S[Soyuz TM-32] undocked from Pirs DC 1 nadir docking port in October 2001.

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Stage 10A - After Separation 2

- Flight 5P [Progress M-45] undocked from Zvezda Service Module aft docking port after unloading propellant, dry cargo, and loading waste in November 2001.
- Flight 6P [Progress M1-7] docked to Zvezda Service Module aft docking port in November 2001.
- Stage UF 1 [STS-108] installed Raffaello MPLM to outfit ISS in December 2001.
- Flight 6P [Progress M1-7] undocked from Zvezda Service Module aft docking port after unloading propellant, dry cargo and loading waste in March 2002. Prior to 6P, Strela 1 is relocated from PMA 1 to Pirs DC 1.
- Flight 7P [Progress M1-8] docked to Zvezda Service Module aft docking port in March 2002.
- Stage 8A [STS-110] delivered ITS S0 truss, airlock spur, CETA lights, Lab umbilicals, PWP and MT in April 2002.
- Flight 4S [Soyuz TM-34] docked to Pirs DC 1 nadir docking port in April 2002.
- Flight 3S [Soyuz TM-33] vehicle undocked from Zarya FGB nadir docking port after 4S Soyuz vehicle arrival to Pirs DC nadir in April 2002.
- Stage UF-2 [STS-111] delivered the Mobile Remote Servicer (MRS) Base System (MBS), Service Module Debris Panel, and the Leonardo MPLM to outfit the ISS in June 2002.
- Flight 7P [Progress M1-8] undocked from Zvezda Service Module Aft docking port after unloading propellant, dry cargo and loading waste in June 2002.

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Stage 10A - After Separation 2

- Eighth Progress vehicle of the ISS assembly sequence docked to Zvezda Service Module aft docking port with solar arrays clocked 45 degrees in June 2002.
- Flight 8P [Progress M1-7] undocked from Zvezda Service Module aft docking port after unloading propellant, dry cargo and loading waste in September 2002.
- Flight 9P [Progress M-9] docked to Zvezda Service Module aft docking port in September 2002.
- Stage 9A [STS-112] docked to PMA 2 and delivered ITS S1, S-band Antenna, CETA Cart A, CETA Lights, S1 External Active Thermal Control System (EATCS) Radiator. ITS S1 was attached to the starboard interface of S0. Install external cameras and stanchions on Destiny Lab [port 13] and S1 truss outboard lower [port 3] in October 2002.
- Flight 5S [Soyuz TMA-1] vehicle docked to Pirs DC 1 nadir docking port in November 2002.
- Flight 4S [Soyuz TM-34] vehicle undocked from Zarya FGB nadir docking port in November 2002.
- Stage 11A [STS-113] Stage 11A delivered the ITS Port 1 (P1) Assembly including the following: P1 truss segment, Wireless Video Systems (WVS) External Transceiver Assemblies (WETA) and stanchions, P1 EATCS Radiator, CETA Cart B, APFR, and UHF antenna in November 2002.
- 9P Progress departed after unloading propellant and dry cargo and loading waste.

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Stage 10A - After Separation 2

- Flight 10P [Progress M-47] docked to Service Module aft docking port with Solar Arrays clocked 45 degrees.
- Stage ULF1 [STS-114] installed Raffaello MPLM to outfit the ISS, and External Stowage Platform (ESP)-2 with four WVS stanchions and Orbital Replacement Units to equip the ISS.
- Flight 6S [Soyuz TMA-2] vehicle docked to Zarya FGB nadir docking port. Soyuz vehicle Solar Arrays clocked 45 degrees.
- Flight 5S [Soyuz TMA-1] vehicle undocked from Pirs DC 1 nadir docking port.
- Flight 11P [Progress M1-10] vehicle docked to the Pirs DC1 nadir docking port.
- Stage 12A [SRS-115] docked to PMA-2 tail nadir. Stage 12A delivered ITS P3, ITS P4, WETA, a Video Stanchion Support Assembly (VSSA) stanchion, 2A and 4A solar arrays, and one PV radiator.
- Flight 10P [Progress M-47] vehicle undocked from Zvezda Service Module aft docking port before 12P Progress launch.
- Flight 12P [Progress M-48] vehicle docked to the Service Module aft docking port with the solar arrays clocked at 45 degrees.
- Stage 12A.1 [STS-116] docked to PMA 2 tail nadir and delivered ITS P5. S1 and P1 EATCS radiators were activated for solar anti-tracking. The P4 SARJ was unlocked. The EATCS loops for the 4A and 2 solar arrays were activated. PVRGF OSE was relocated fromITS P5 to the MBS LEE. P6 truss Channel 4B Solar Array [port array] was deactivated and retracted. The Pump Module, DDCU Cold Plate, and MBSU Cold Plate were transferred to the ESP 2. The PFCS was transferred from ESP 1 to the ICC.

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Stage 10A - After Separation 2

- Stage 13A [STS-117] docked to PMA 2 tail nadir and delivered ITS S3 and ITS S4, and 1A and 3A solar arrays. Stage 13A delivered ITS S3 and S4 to ISS. The ITS P6 aft EEATCS radiator was transferred from P6 aft to S4 nadir using the PVRGF and the SSRMS. And redefined as the ITS S4 PVTCS radiator. The 1A and 3A Solar Arrays were deployed. PVRGF was relocated from S4 truss radiator to MBS LEE, then to the starboard EEATCS radiator on ITS P6.
- Flight 12P [Progress M-48] vehicle undocked from Zvezda Service Module aft docking port.
- Flight 7S [Soyuz TMA-2] vehicle docked to the Zvezda Service Module aft docking port. Soyuz vehicle Solar Arrays clocked 45 degrees.
- Flight 6S [Soyuz TMA-2] vehicle undocked from the Zarya FGB nadir docking port.
- Flight 7S [Soyuz TMA-2] vehicle relocated from the Zvezda Service Module aft docking port to the Zarya FGB nadir docking port.
- Flight 11P [Progress M1-10] vehicle undocked from Pirs DC1 nadir docking port.
- Flight 13P [Progress M1-11] vehicle launched and delivered to orbit by Soyuz launch vehicle.
- Stage 13A.1 [STS-118] docked to the PMA 2 docking port and delivered the ITS S5 truss to the ISS. EAS was moved from P6 to the ICC for return.
- Flight 14P [Progress] docked to the Zvezda Service Module aft docking port. Progress is clocked 45 degrees. PMA3 Relocated from Node 1 port to Node 1 nadir. P6 truss PV radiator retracted, Removed FPP from P6 and place it inside the ISS.

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Stage 10A - After Separation 2

- Stage 15A [STS-119] docked to the PMA 2 docking port. Stage 15A delivered ITS S6 to the ISS. Installed ITS S6 to the ITS S5 truss. Deployed S6 truss PV radiator. Deployed and activated S6 truss channels 3B and 1B Solar Arrays. Detached P6 truss from Z1 truss and relocated it to the port side interface of ITS P5. Deployed P6 truss PVTCS nadir radiator. Deployed and activated P6 truss channel 4B and 2B Solar Arrays.
- Flight 13P [Progress M1-11] vehicle undocked from Pirs DC1 nadir docking port.
- Flight 15P [Progress] docked to the Pirs DC1 nadir docking port.
- Stage 10A [STS-120] docked to PMA 2 tail nadir and delivered Node 2. Node 2 installed on the Unity Node 1 port Common Berthing Mechanism (CBM) (keel pin aft nadir).
- Stage 10A After Separation 1, Relocated PMA 2 from the forward CBM of the Destiny US Lab to the port CBM of Node 2 while Node 2 is still attached to Node 1 port CBM.

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Stage 10A - After Separation 2

- Relocate the Node 2 and PMA 2 to the Forward CBM of the Destiny Lab (Node 2 keel pin oriented port nadir).
- Deploy upper and lower EATCS radiators on ITS P1.
- Deploy upper and lower EATCS radiators on ITS S1.

STEP 001

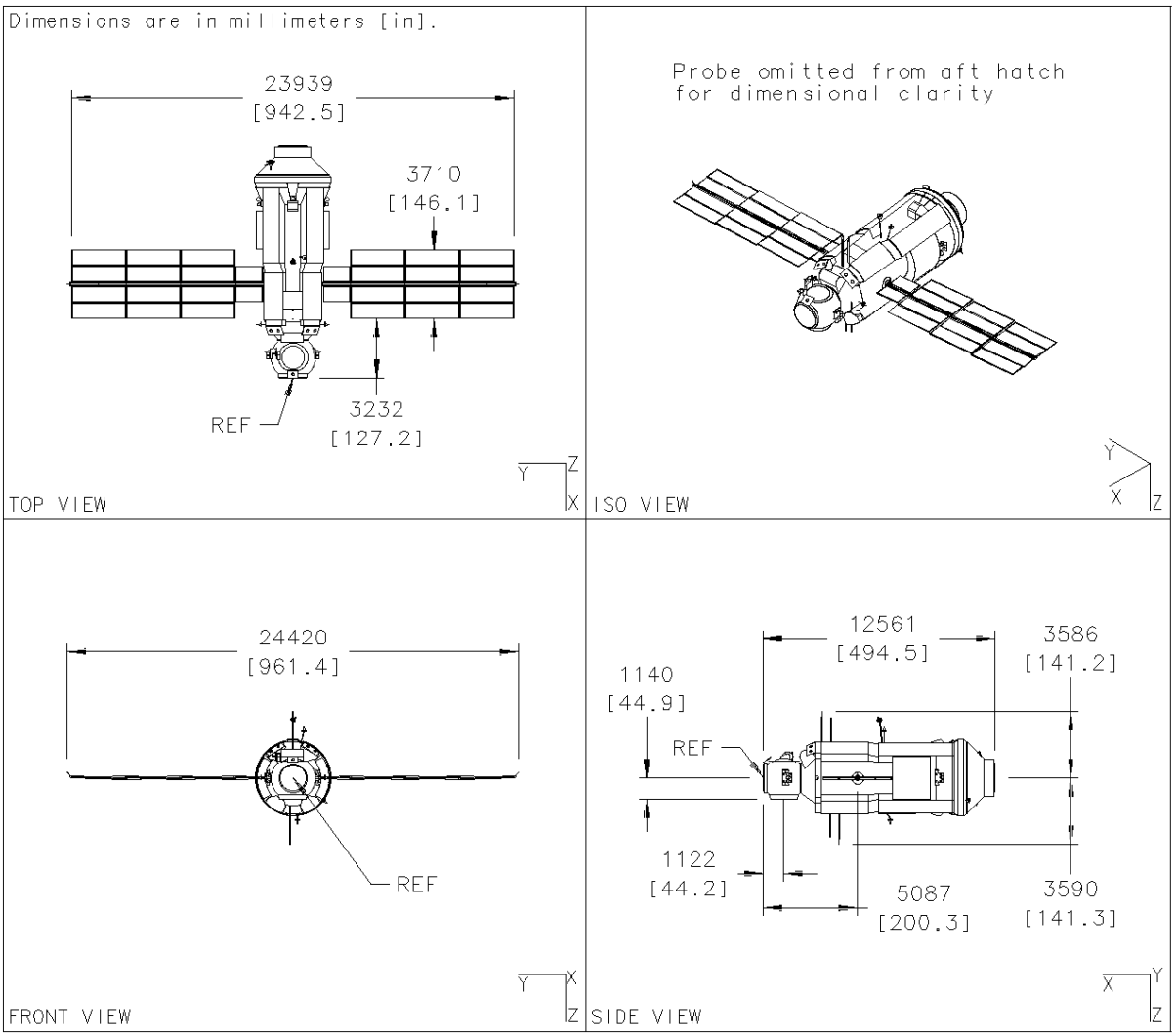
Stage 10A - After Separation 2

Element Properties:

Zarya FGB Core (including propellant) at 13P_AS

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
22394	X =	-17321	X =	-10016	-25323	36221	1693	-15
	Y =	-40	Y =	-6	0	1693	510687	-150
	Z =	4175	Z =	4142	0	-15	-150	497139

Reference Point Description: Center of forward APAS interface plane



STEP 001

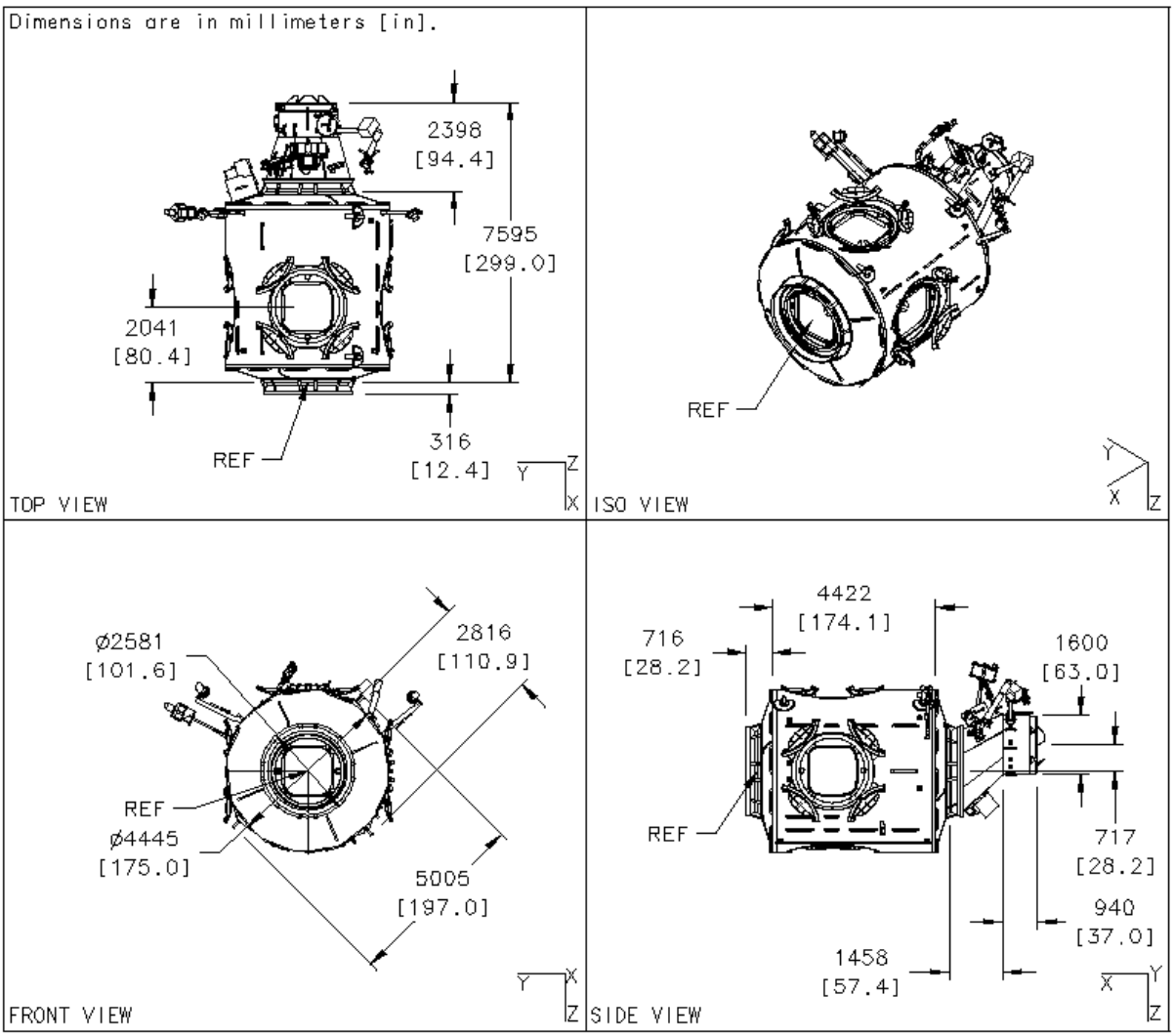
Stage 10A - After Separation 2

Element Properties:

Unity Node 1 with PMA 1 Assembly

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
12819	X =	-5333	X =	-2422	-32917	28267	227	-3921
	Y =	14	Y =	-2	-714	227	57771	-235
	Z =	4773	Z =	4856	-4	-3921	-235	56337

Reference Point Description: Center of forward CBM interface plane



STEP 001

Stage 10A - After Separation 2

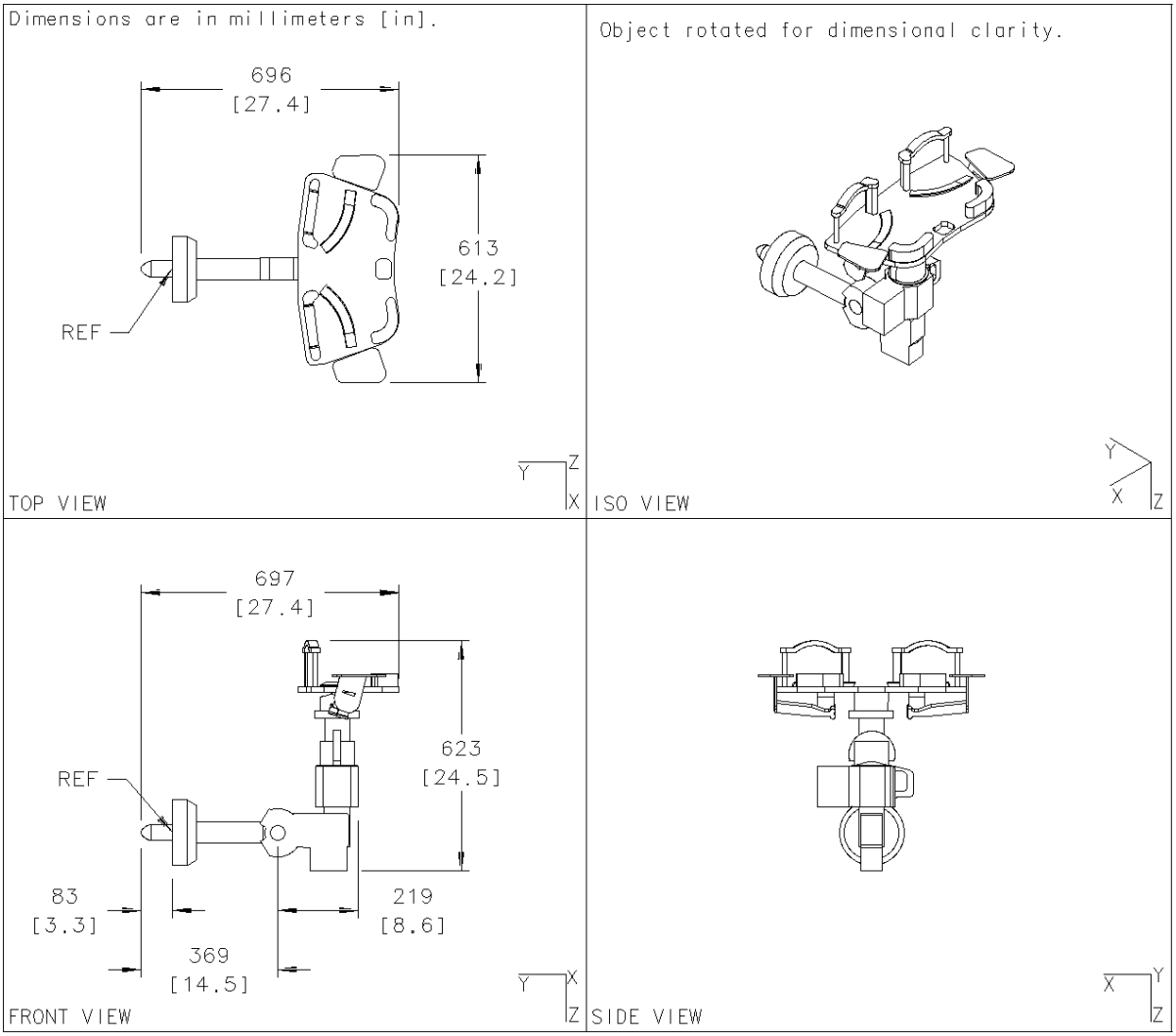
(RSA Flight ID: 212)

Element Properties:

APFR (on PMA 1 02-04 WIF)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
N/A	X =	N/A	X =	-9283	-26056	N/A	N/A	N/A
	Y =	N/A	Y =	-289	842	N/A	N/A	N/A
	Z =	N/A	Z =	3300	283	N/A	N/A	N/A

Reference Point Description: Center of interface plane with WIF



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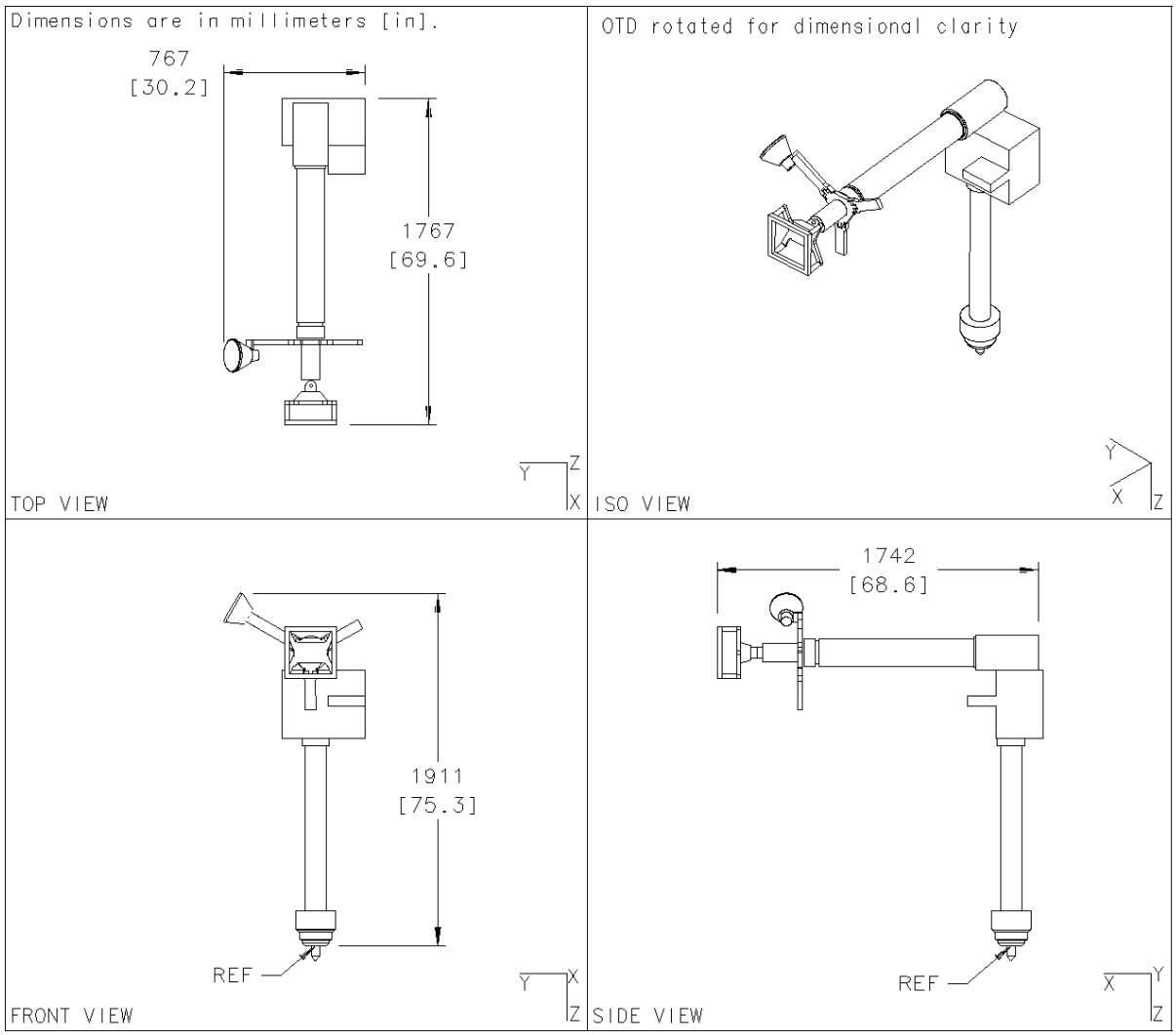
Stage 10A - After Separation 2

Element Properties:

OTD (on PMA 1 02-05 WIF)

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
N/A	X =	N/A	X = -9283	-26056	N/A	N/A	N/A
	Y =	N/A	Y = -666	595	N/A	N/A	N/A
	Z =	N/A	Z = 3547	660	N/A	N/A	N/A

Reference Point Description: Center of interface plane with Worksite Interface (WIF)



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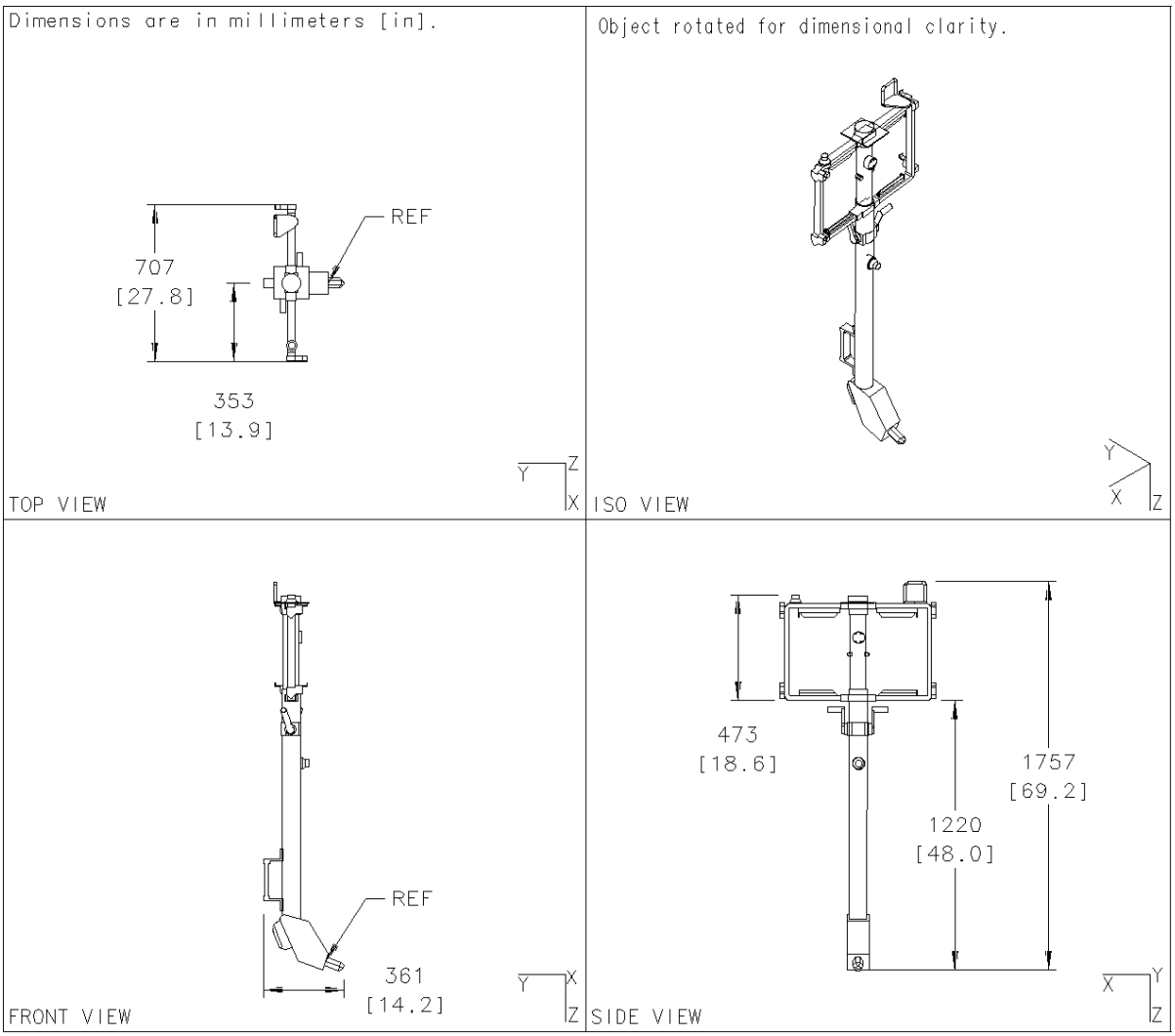
Stage 10A - After Separation 2

Element Properties:

Portable Foot Restraint and Workstation Stanchion (PFRWS) (on PMA 1 01-02 WIF)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
N/A	X =	N/A	X =	-8308	-27031	N/A	N/A	N/A
	Y =	N/A	Y =	1142	742	N/A	N/A	N/A
	Z =	N/A	Z =	3400	-1148	N/A	N/A	N/A

Reference Point Description: Center of interface plane with APFR socket



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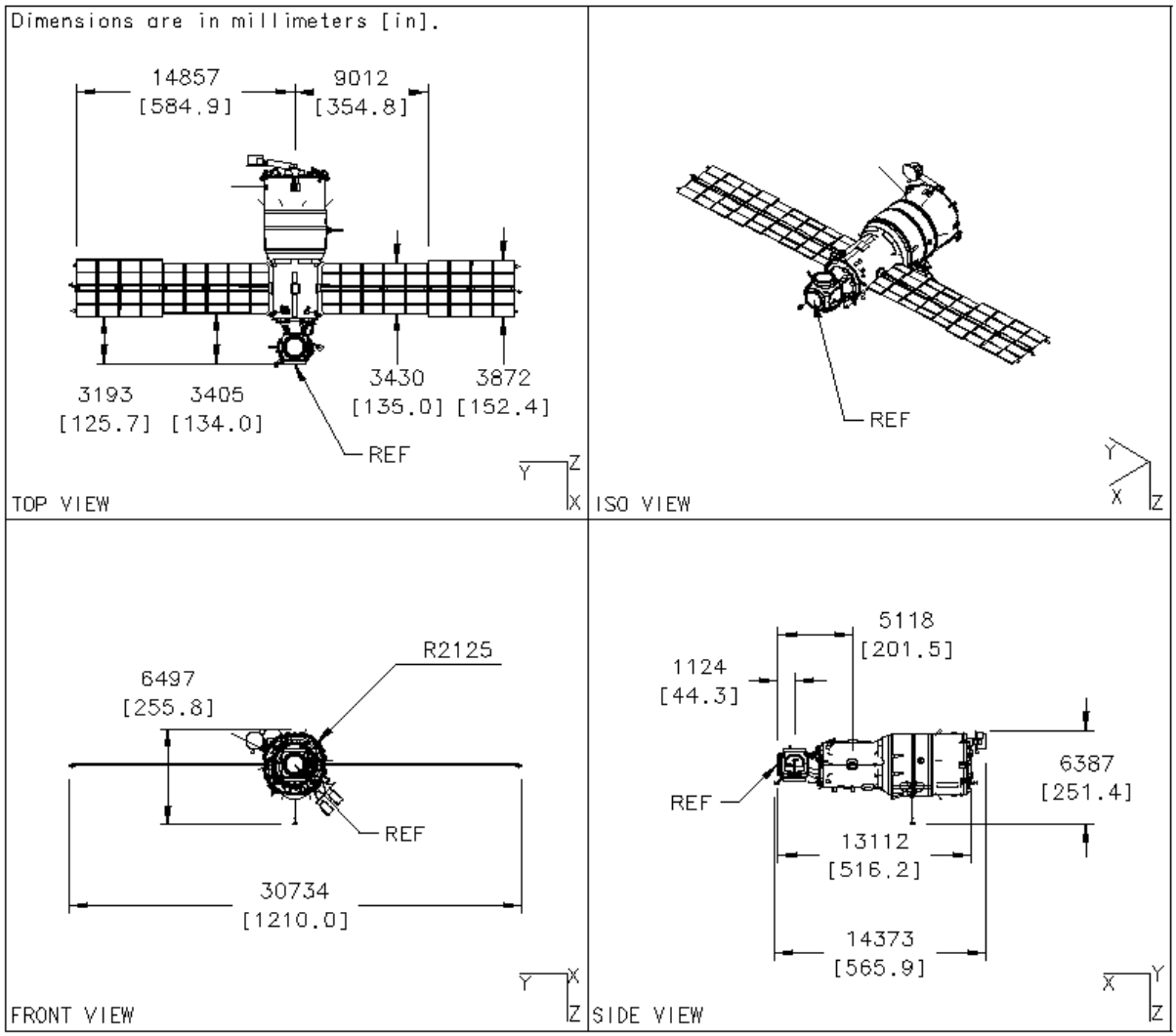
Stage 10A - After Separation 2

Element Properties:

Zvezda Service Module Assembly (excluding solar array mass contribution)

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
23260	X =	-30615	X =	-22579	-12760	37983	4644	-3531
	Y =	1	Y =	-6	0	4644	273654	453
	Z =	4125	Z =	4142	0	-3531	453	264630

Reference Point Description: Center of forward docking interface plane



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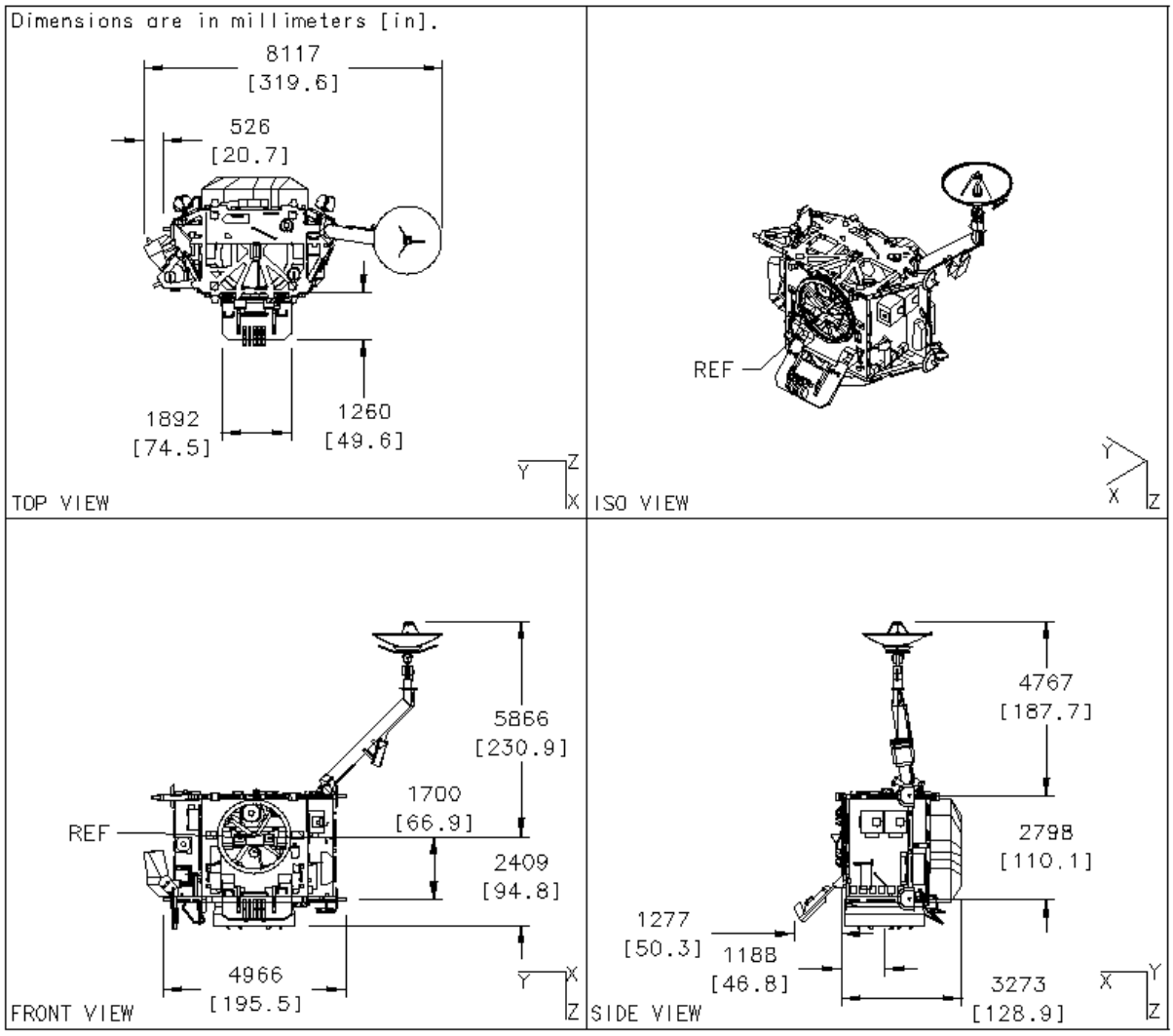
Stage 10A - After Separation 2

Element Properties:

Z1 Assembly (deployed Ku-Band antenna and umbilical tray; keel moved)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
8716	X =	-4782	X =	-3271	-32068	28642	248	142
	Y =	-102	Y =	0	3667	248	20145	-3468
	Z =	630	Z =	475	-6	142	-3468	21236

Reference Point Description: Center of forward CBM interface plane



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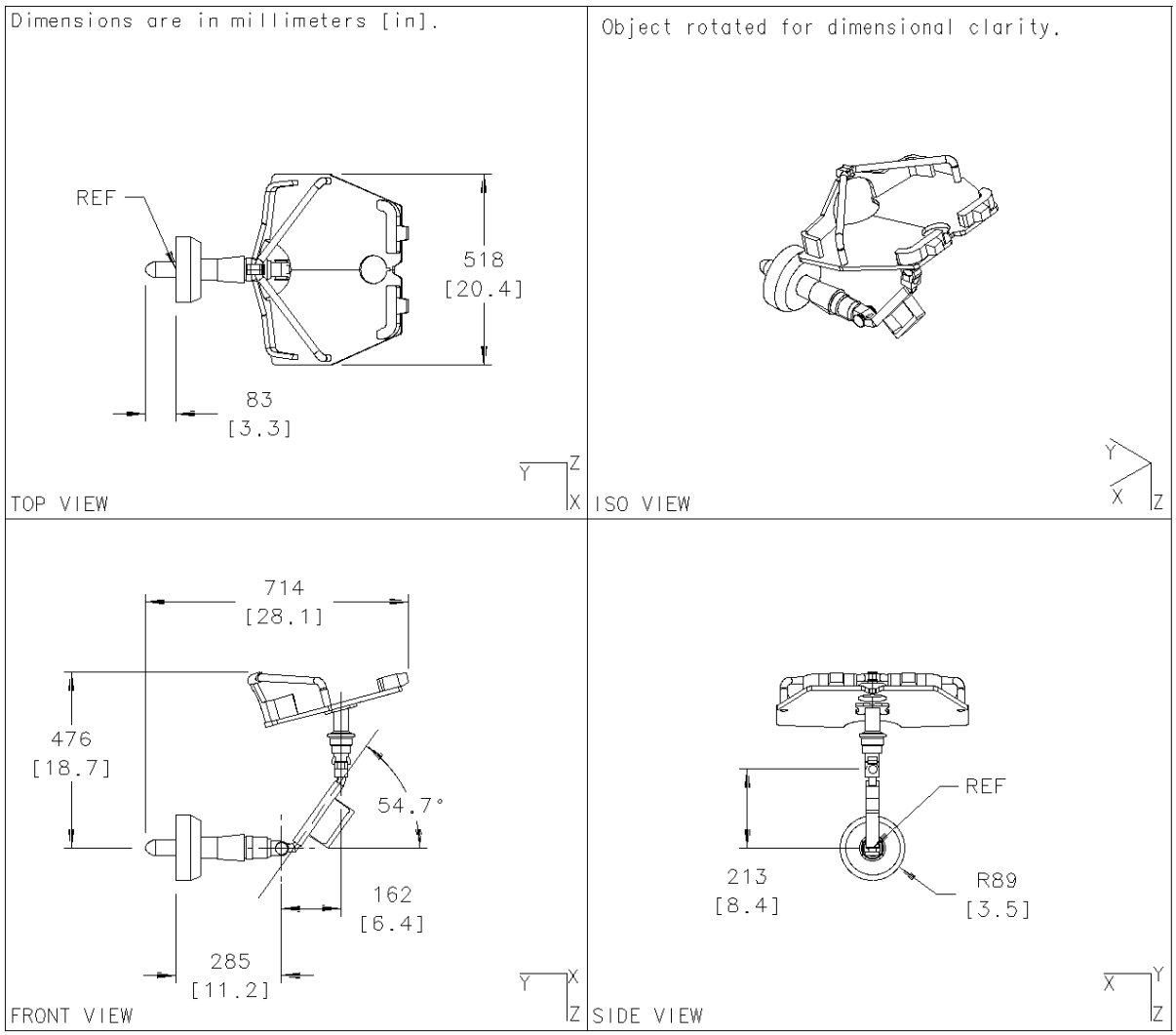
Stage 10A - After Separation 2

Element Properties:

Interoperable APFR (on Z1 02-01 WIF)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
N/A	X =	N/A	X =	-5451	-29888	N/A	N/A	N/A
	Y =	N/A	Y =	1828	2072	N/A	N/A	N/A
	Z =	N/A	Z =	2070	-1834	N/A	N/A	N/A

Reference Point Description: Center of interface plane with WIF



STEP 001

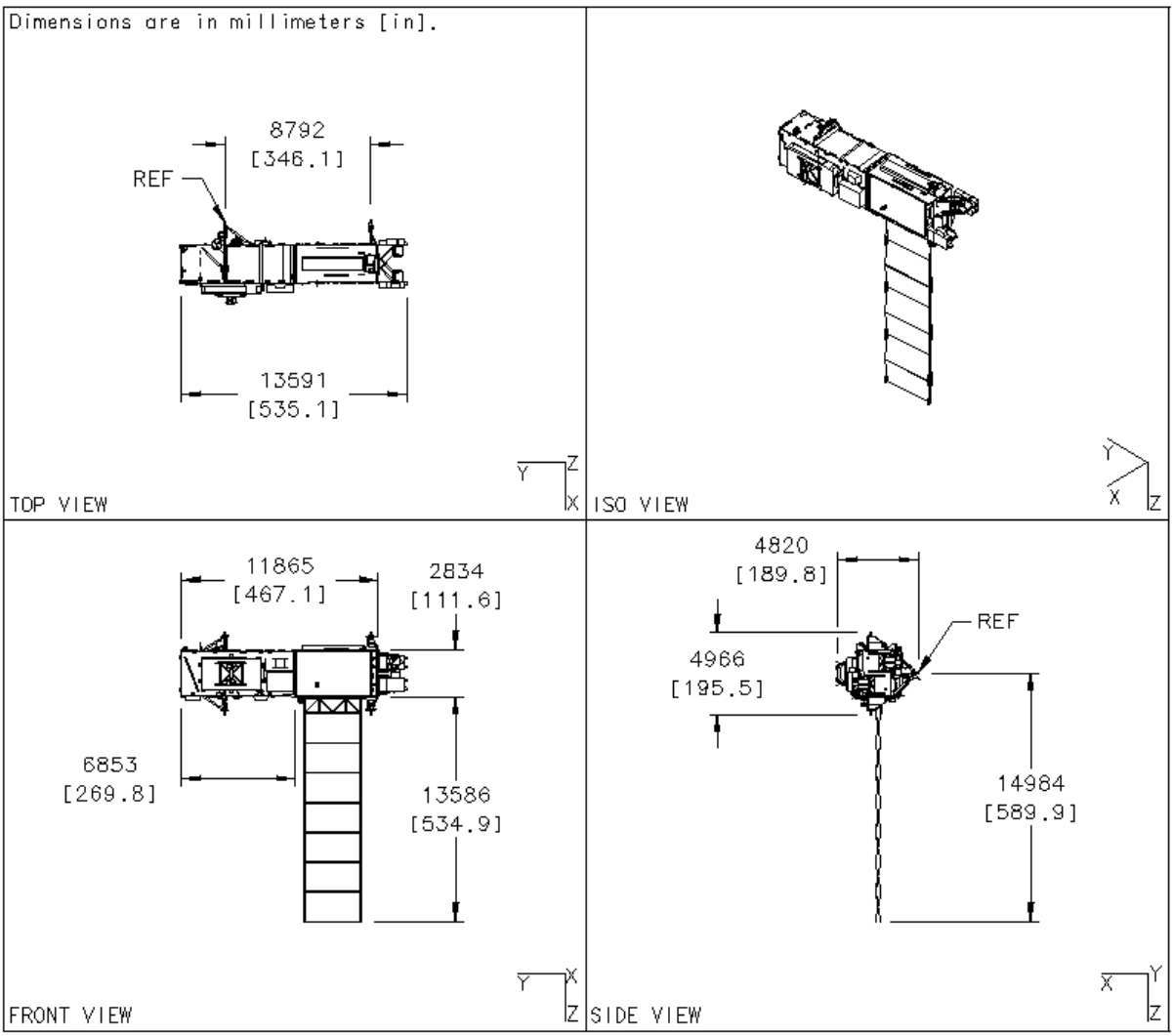
Stage 10A - After Separation 2

Element Properties:

P6 Assembly (with nadir EATCS radiator deployed and forward radiator stowed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
13139	X =	-208	X =	-2855	-32484	188168	-7753	1083
	Y =	-43508	Y =	-38143	4147	-7753	45340	2508
	Z =	252	Z =	-5	38137	1083	2508	161494

Reference Point Description: Center of the end of the starboard keel pin



STEP 001

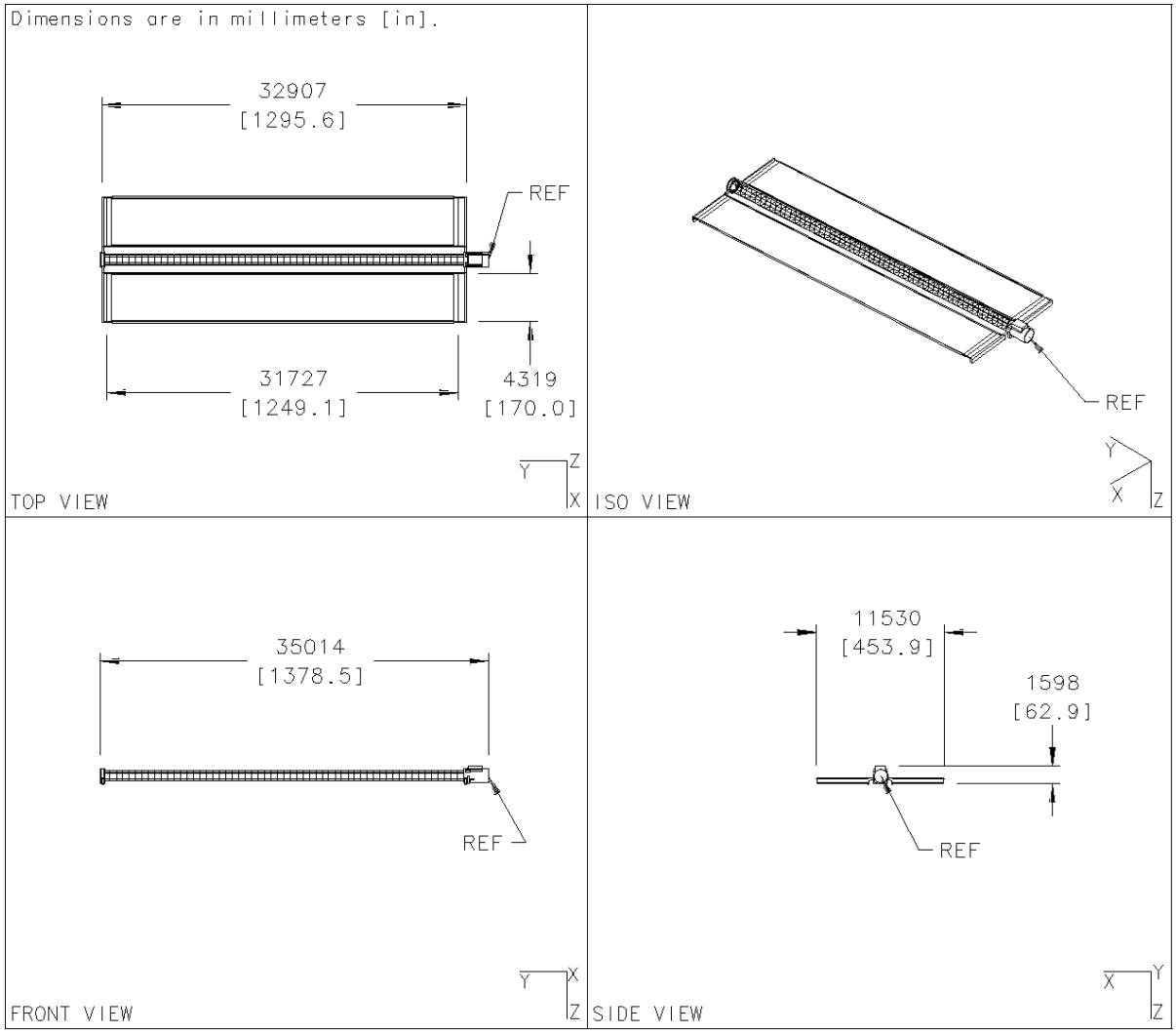
Stage 10A - After Separation 2

Element Properties:

P6 Solar Array (POA)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1062	X =	-14793	X =	-1808	-33531	8317	41	91
	Y =	-48582	Y =	-48559	4917	41	176381	0
	Z =	-547	Z =	-775	48553	91	0	184491

Reference Point Description: Center of PV mast canister interface with beta gimbal



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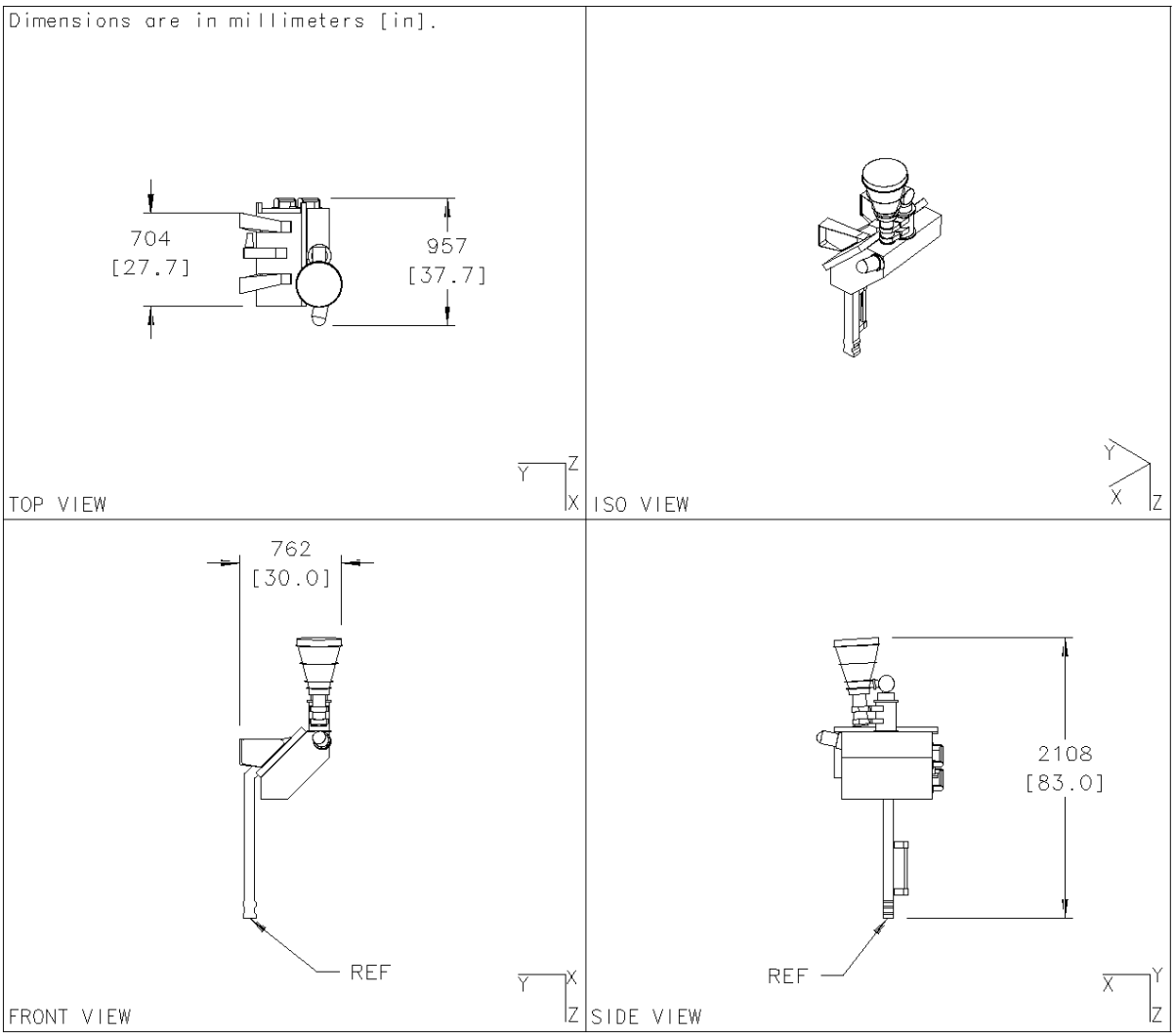
Stage 10A - After Separation 2

Element Properties:

S-band Antenna on P1

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
103	X =	174	X =	112	-35451	17	1	2
	Y =	-9062	Y =	-8670	6288	1	18	-5
	Z =	-3527	Z =	-2146	8664	2	-5	7

Reference Point Description: Center of interface plane



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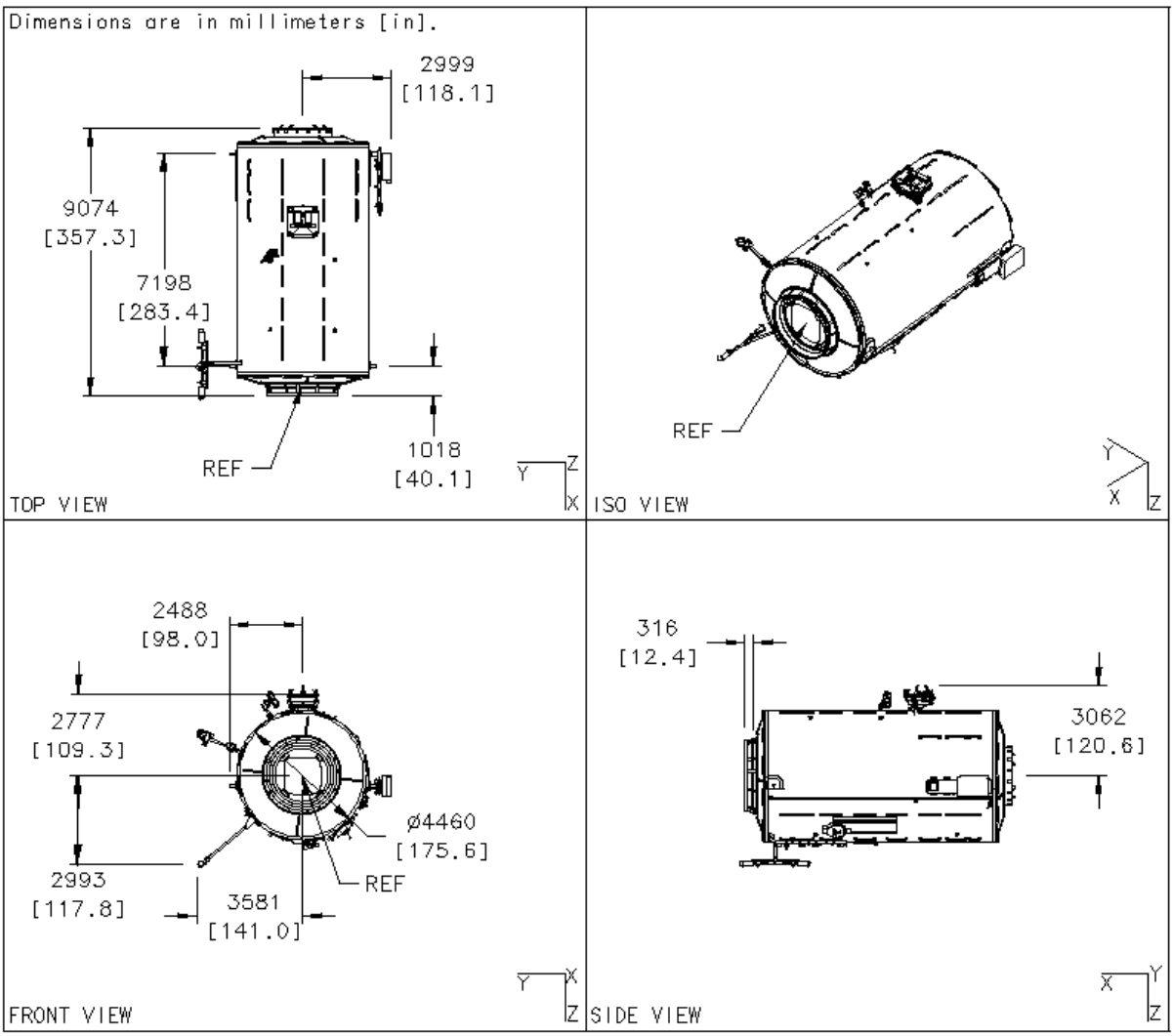
Stage 10A - After Separation 2

Element Properties:

Destiny Lab module

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
26325	X =	1931	X =	6302	-41641	71804	-1862	-4685
	Y =	-118	Y =	7	-712	-1862	169418	827
	Z =	4763	Z =	4854	-13	-4685	827	174432

Reference Point Description: Center of forward CBM interface plane



STEP 001

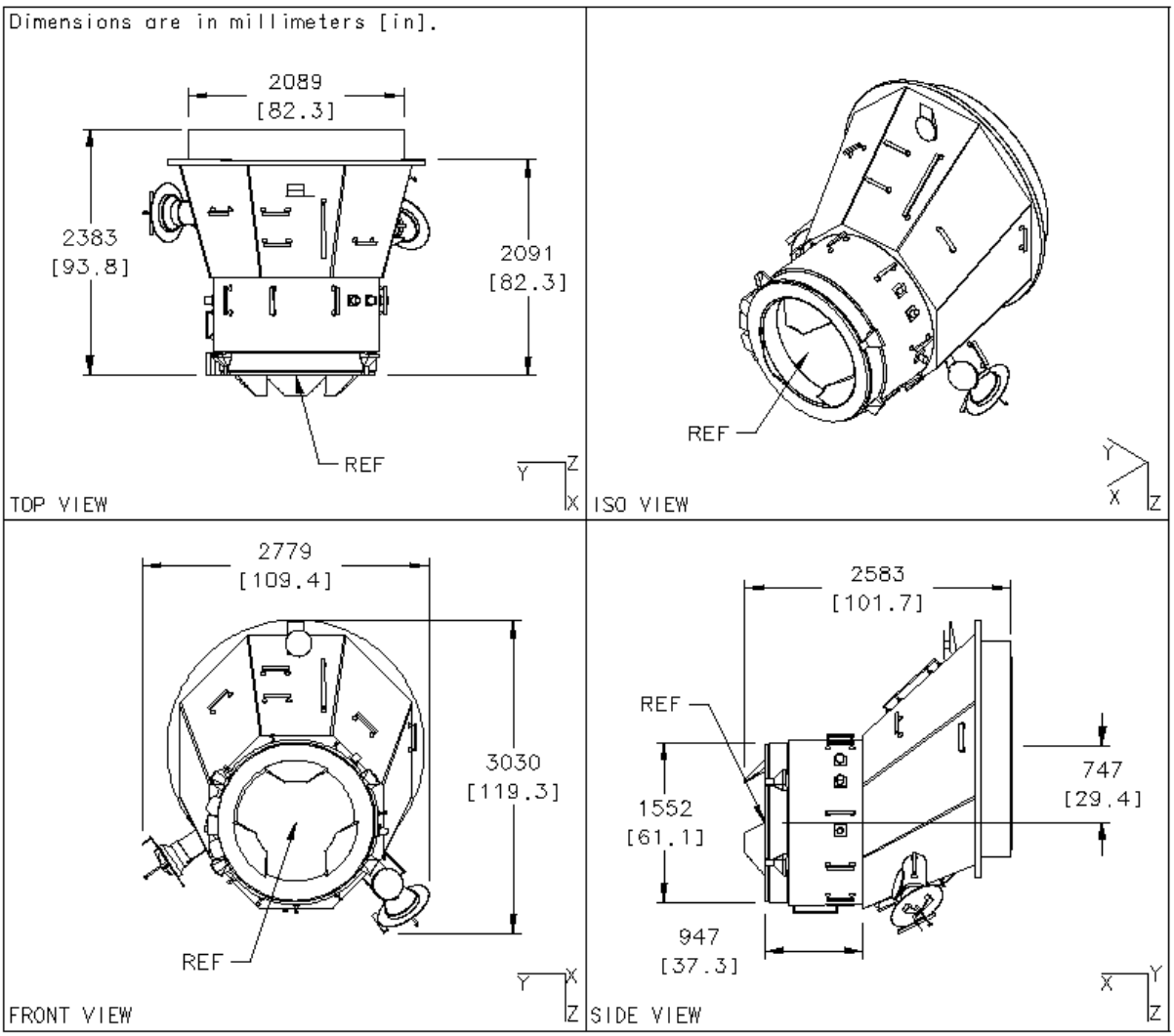
Stage 10A - After Separation 2

Element Properties:

PMA2 (on Italian Node 2 forward CBM)

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
1164	X =	14160	X =	15427	-50766	979	-27	-237
	Y =	25	Y =	10	-1431	-27	1273	-4
	Z =	5291	Z =	5573	-16	-237	-4	1203

Reference Point Description: Center of the forward APAS interface plane



STEP 001

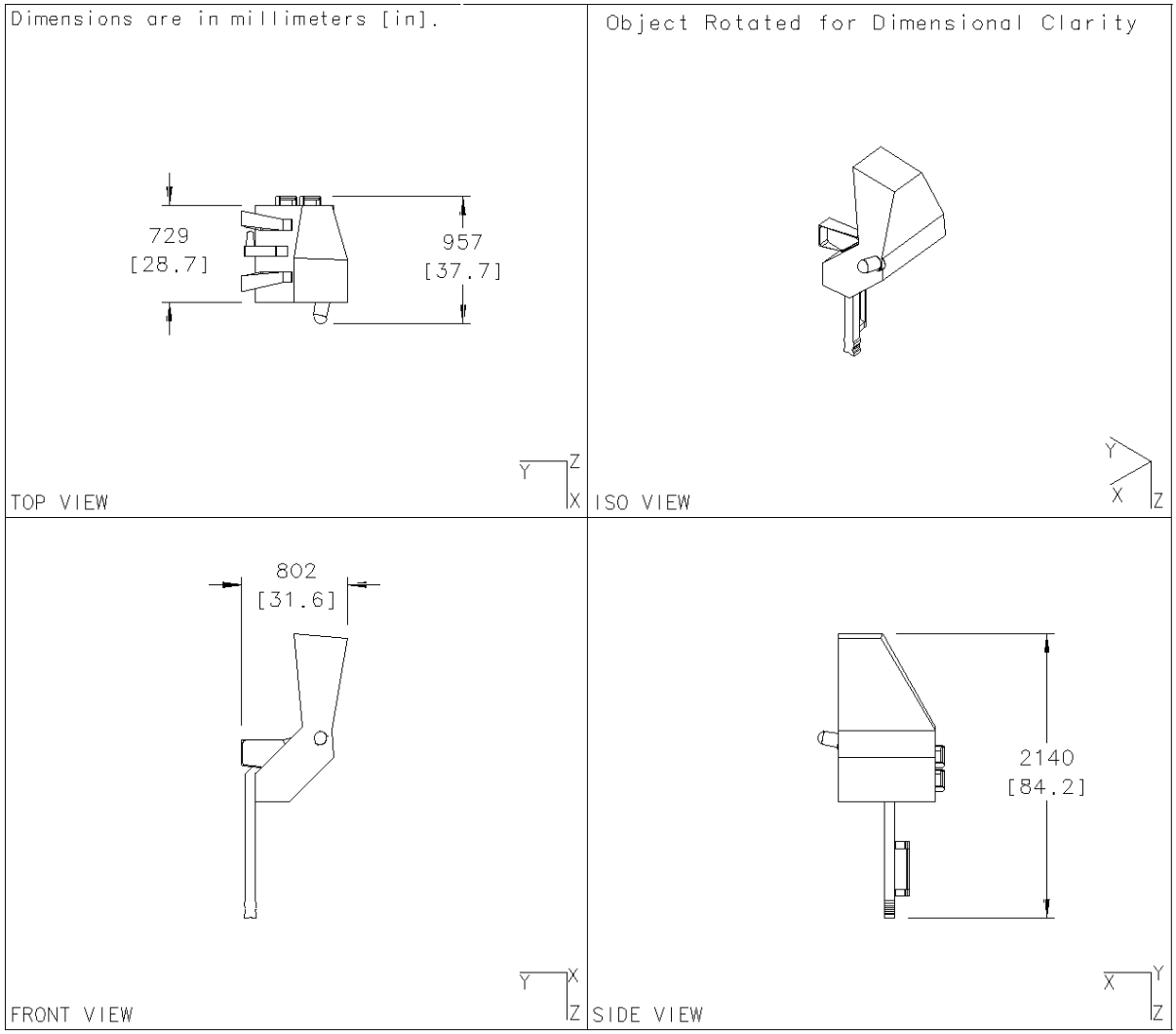
Stage 10A - After Separation 2

Element Properties:

S-band Antenna (stowed on Z1, spare)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
103	X =	-4525	X =	-4648	-30691	18	1	0
	Y =	2562	Y =	2185	1158	1	18	5
	Z =	1604	Z =	2984	-2191	0	5	7

Reference Point Description: Center of S-band base



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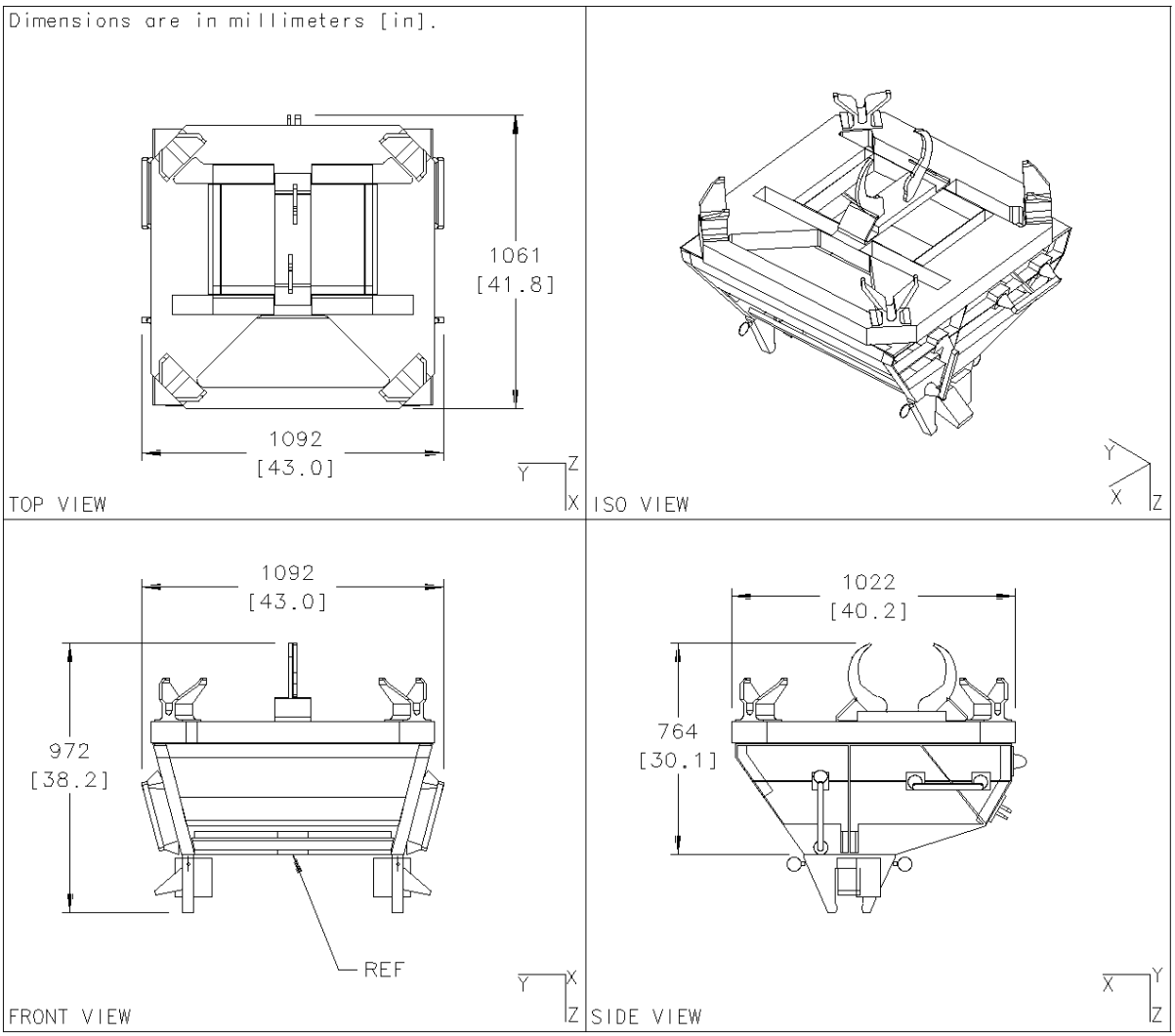
Stage 10A - After Separation 2

Element Properties:

Laboratory Cradle Assembly (LCA)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
N/A	X =	N/A	X =	812	-36151	N/A	N/A	N/A
	Y =	N/A	Y =	0	1589	N/A	N/A	N/A
	Z =	N/A	Z =	2553	-6	N/A	N/A	N/A

Reference Point Description: Center of nadir LCA base



STEP 001

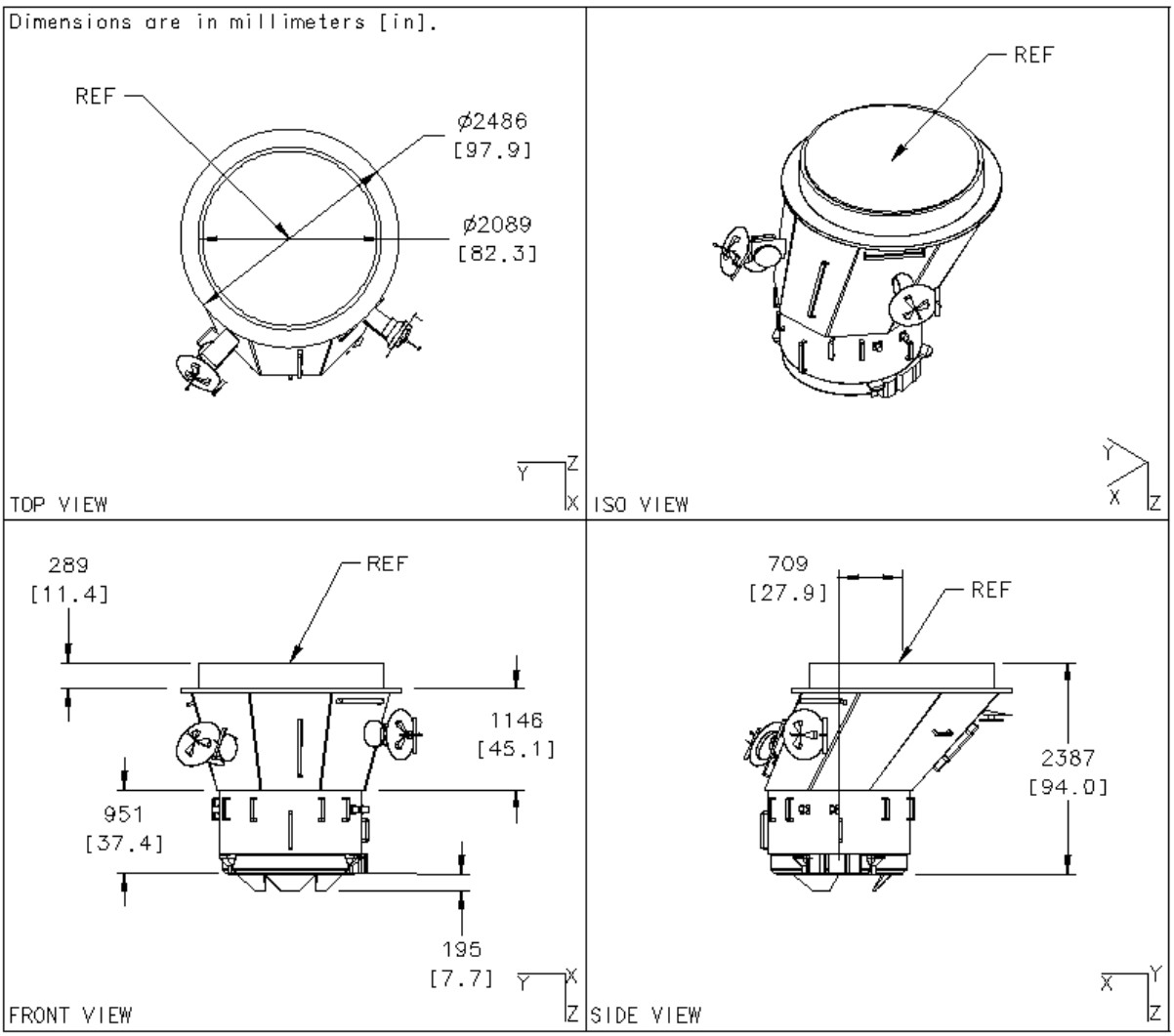
Stage 10A - After Separation 2

Element Properties:

PMA 3 (on Unity Node 1 nadir CBM, rotated for orbiter tail forward docking)

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
1168	X =	-4033	X =	-4463	-30876	1186	4	-220
	Y =	24	Y =	-6	-2706	4	1246	23
	Z =	7969	Z =	6848	0	-220	23	991

Reference Point Description: Center of the zenith CBM interface



STEP 001

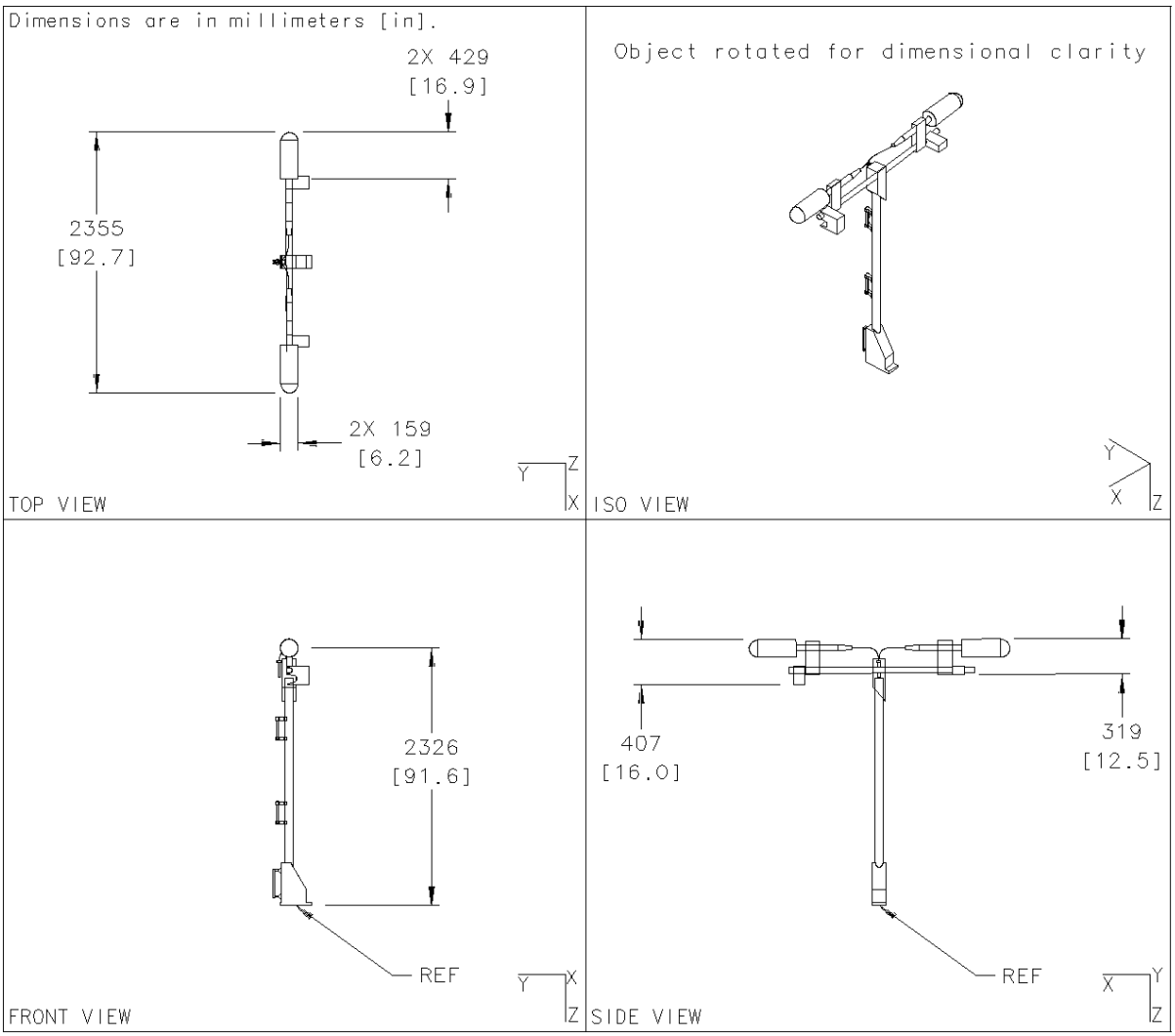
Stage 10A - After Separation 2

Element Properties:

Destiny Lab UHF Antenna

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
43	X =	5571	X =	5573	-40912	36	0	0
	Y =	2866	Y =	1684	-2160	0	32	-18
	Z =	7364	Z =	6302	-1690	0	0	37

Reference Point Description: Center of base interface



STEP 001

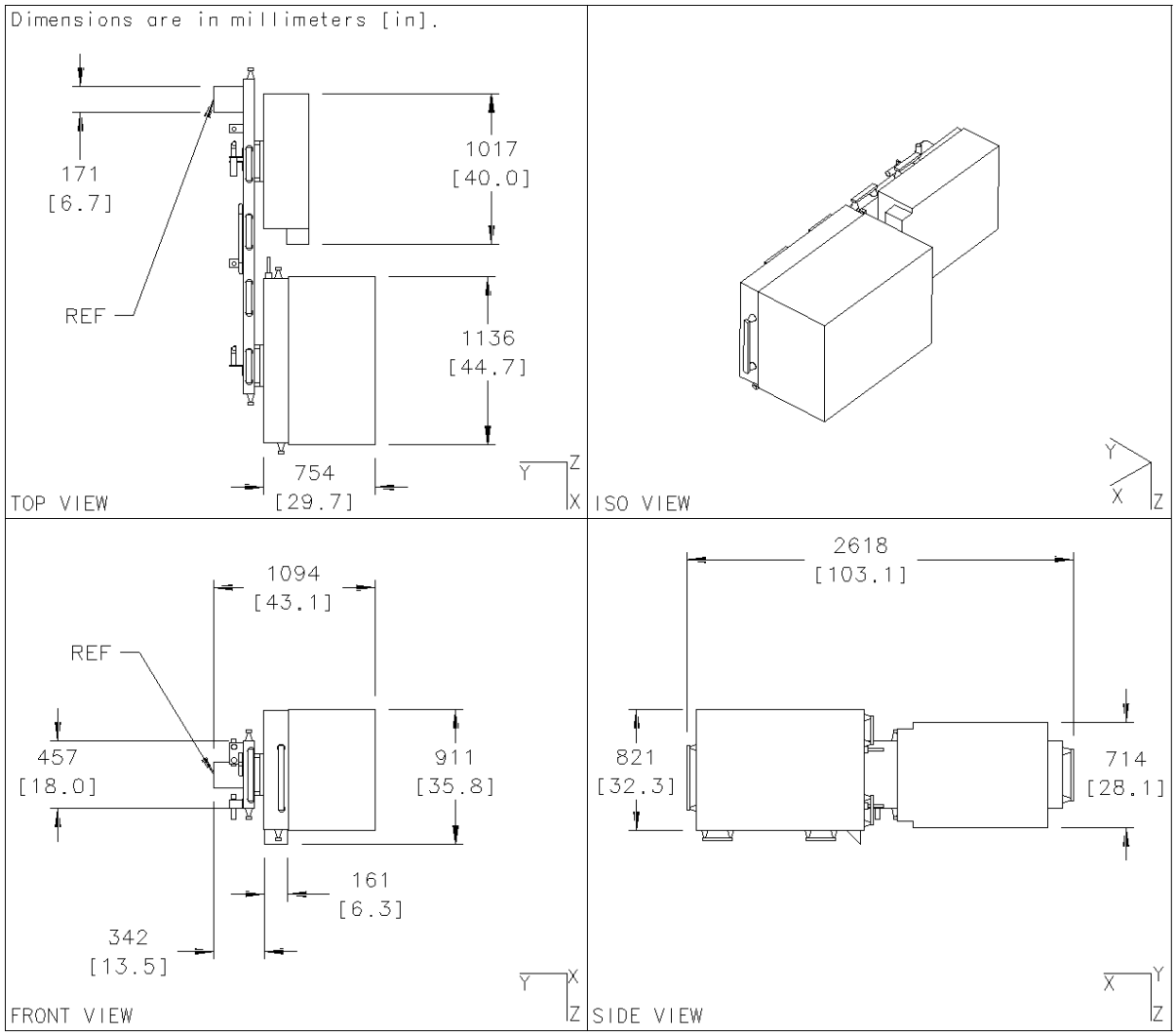
Stage 10A - After Separation 2

Element Properties:

ESP1, with Lab DCSU

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
390	X =	-699	X =	-1584	-33755	47	21	3
	Y =	-2870	Y =	-2357	-1061	21	259	-1
	Z =	5194	Z =	5203	2351	3	-1	250

Reference Point Description: Center of the interface plane with trunnion pin



STEP 001

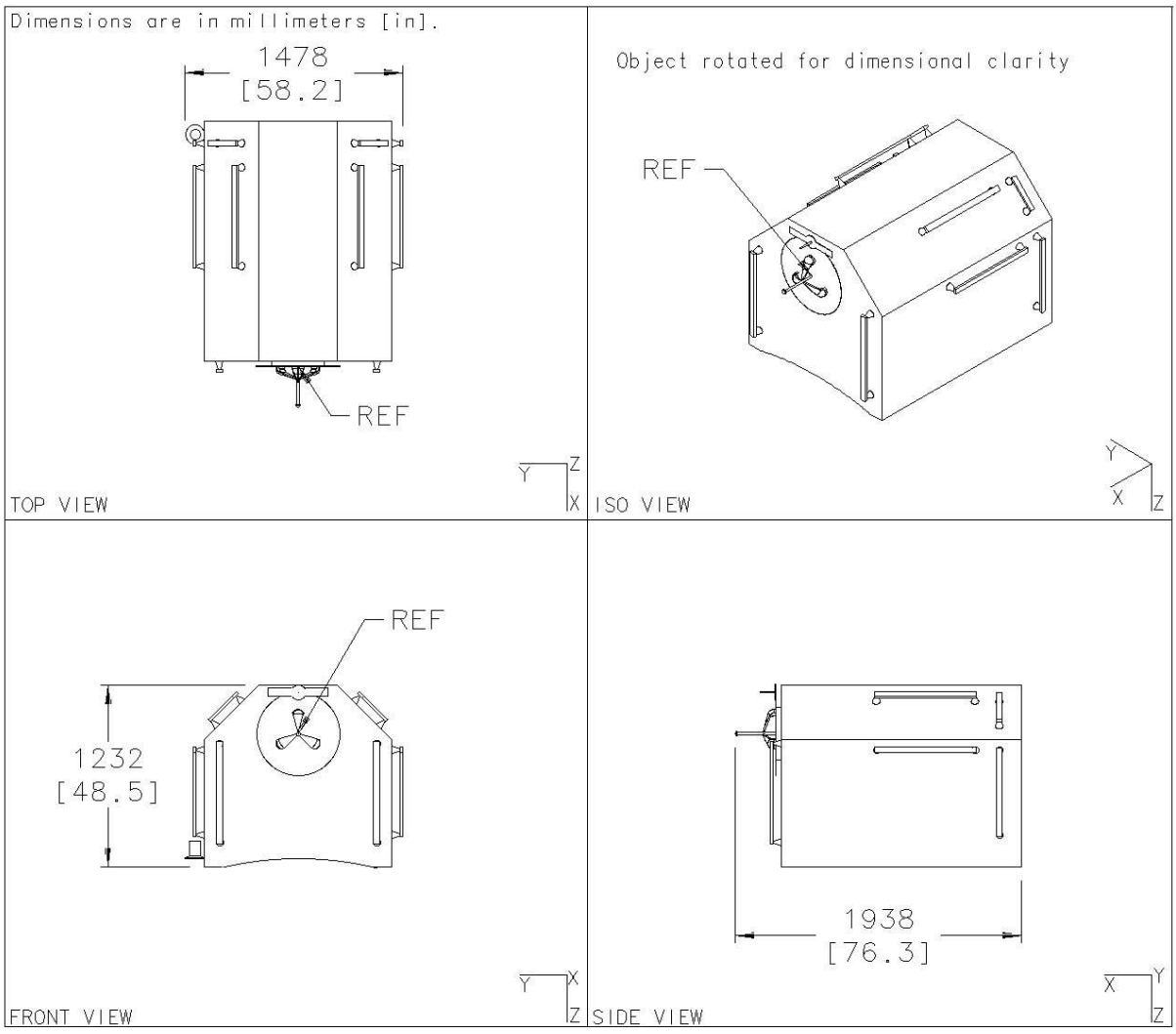
Stage 10A - After Separation 2

Element Properties:

HPGA-1

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
N/A	X =	N/A	X =	-6847	-28492	N/A	N/A	N/A
	Y =	N/A	Y =	4325	-2593	N/A	N/A	N/A
	Z =	N/A	Z =	6735	-4331	N/A	N/A	N/A

Reference Point Description: Center of HPGA grapple fixture pin base plane



STEP 001

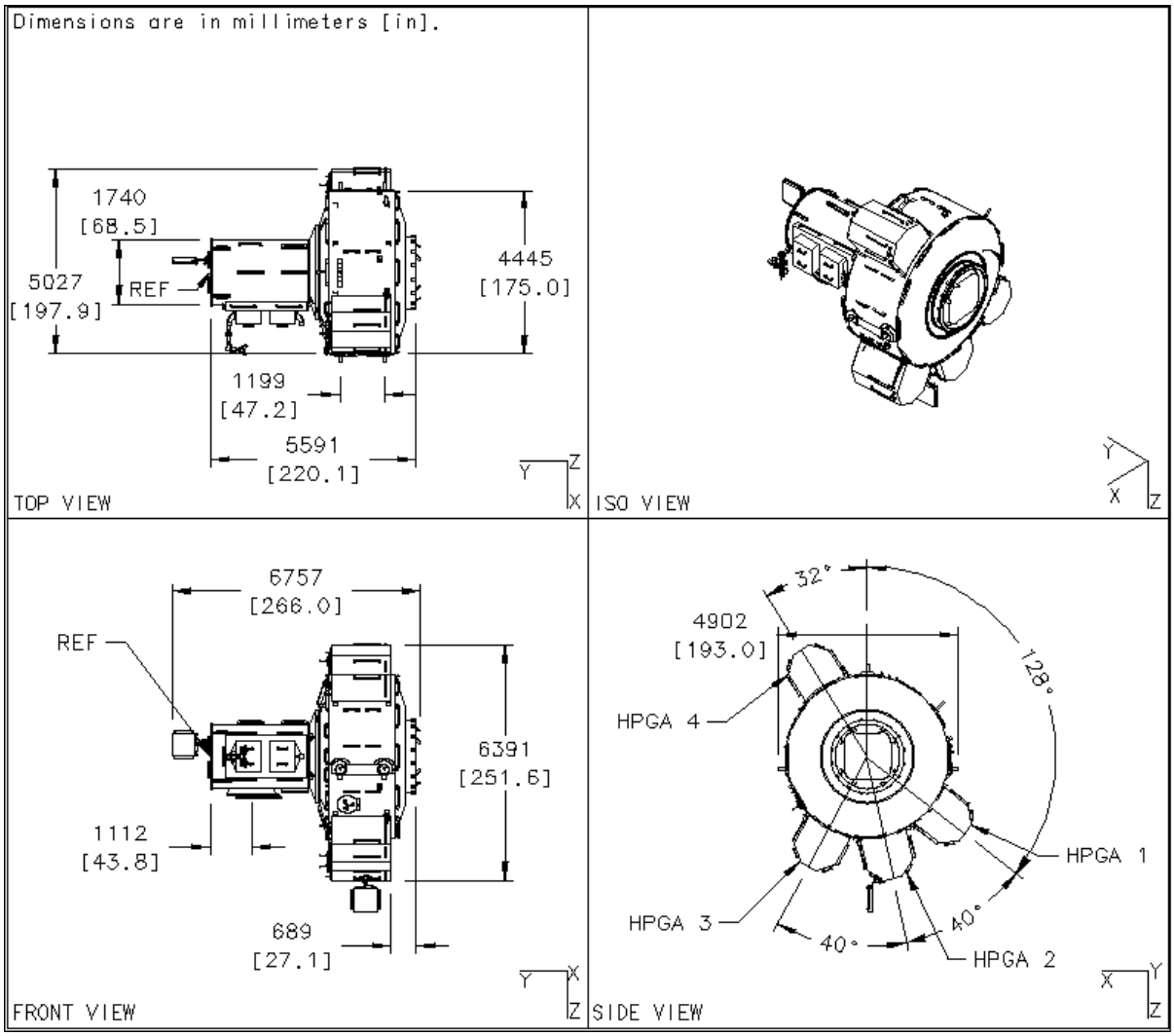
Stage 10A - After Separation 2

Element Properties:

Airlock Assembly (Airlock Core with external equipment plus 4 HPGA units)

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
9425	X =	-4420	X =	-4469	-30870	30869	-711	2912
	Y =	3802	Y =	7564	-708	-711	28513	116
	Z =	5194	Z =	4850	-7570	28513	116	688

Reference Point Description: Center of starboard crew lock end face



STEP 001

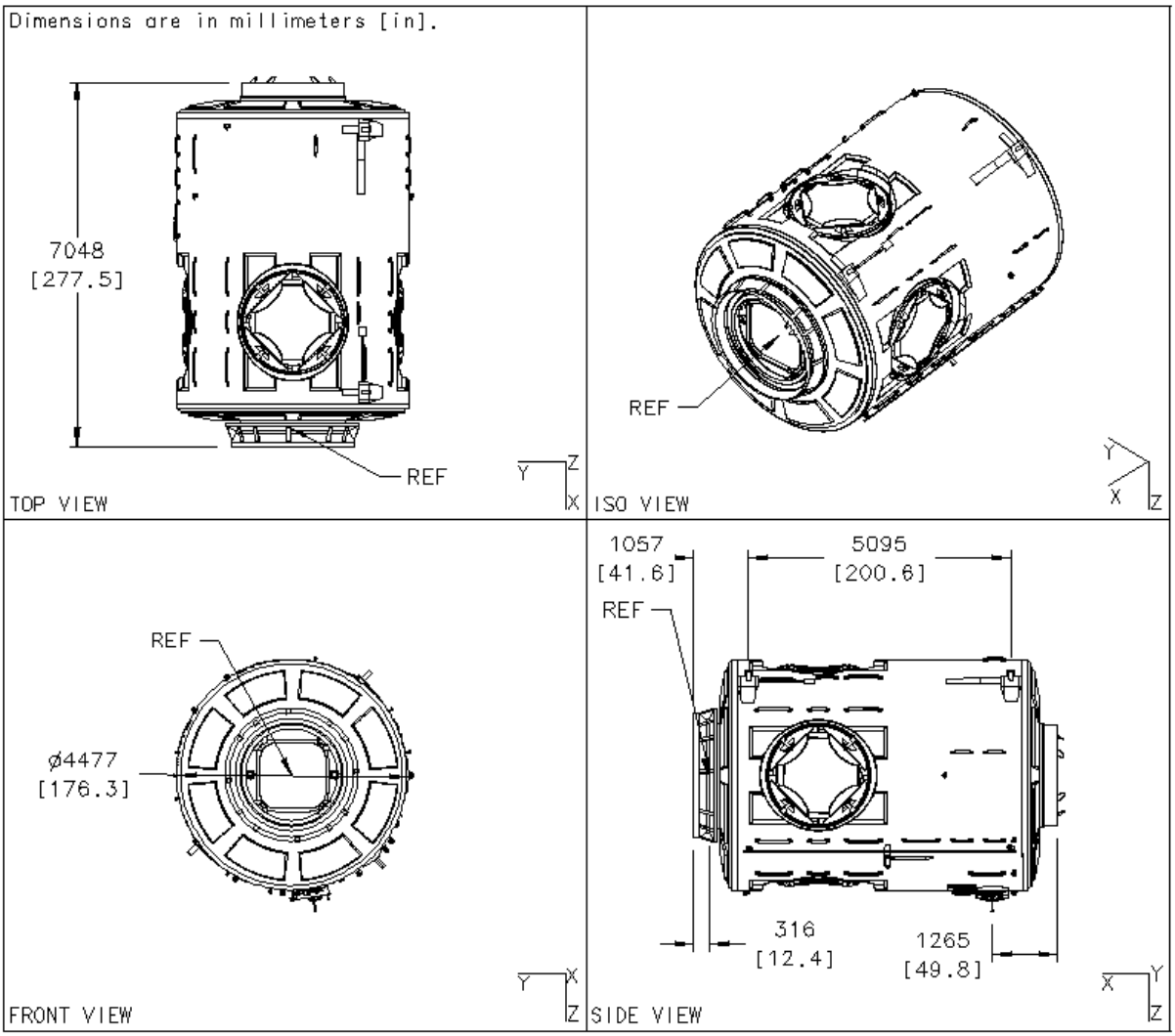
Stage 10A - After Separation 2

Element Properties:

Italian Node 2 Assembly (installed on Destiny Lab forward CBM)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
14072	X =	9888	X =	13038	-48377	32830	-574	-407
	Y =	-15	Y =	8	-719	-574	62259	-266
	Z =	4873	Z =	4861	-14	-407	-266	62092

Reference Point Description: Center of forward CBM interface



STEP 001

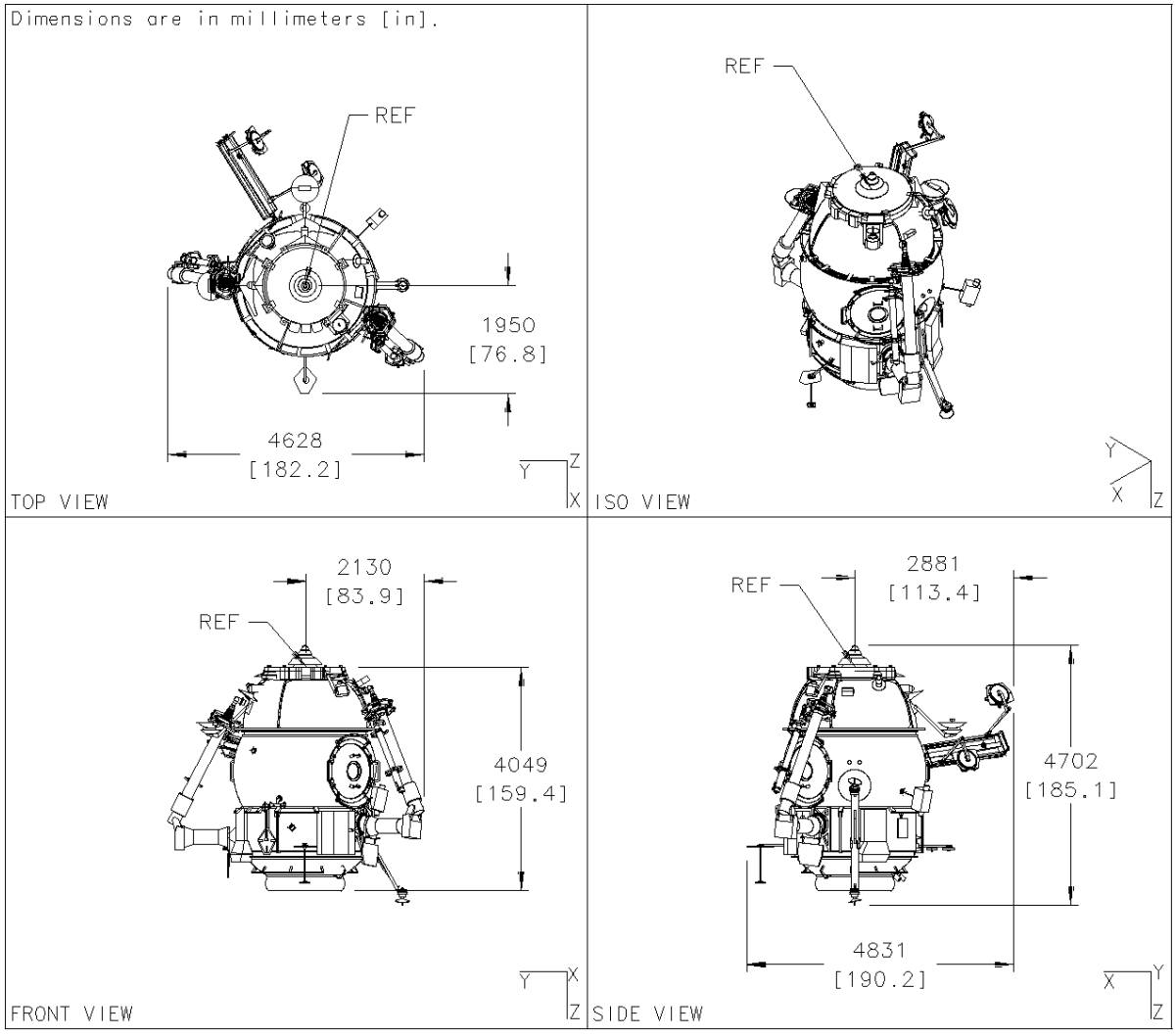
Stage 10A - After Separation 2

Element Properties:

Pirs DC1 Assembly (deployed BPM Ladder and Strela 1 & 2)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
3145	X =	-23800	X =	-23701	-11638	4120	26	-4
	Y =	258	Y =	-6	-1117	26	4112	-7
	Z =	7430	Z =	5259	0	-5	-7	2051

Reference Point Description: Center of zenith docking interface plane



STEP 001

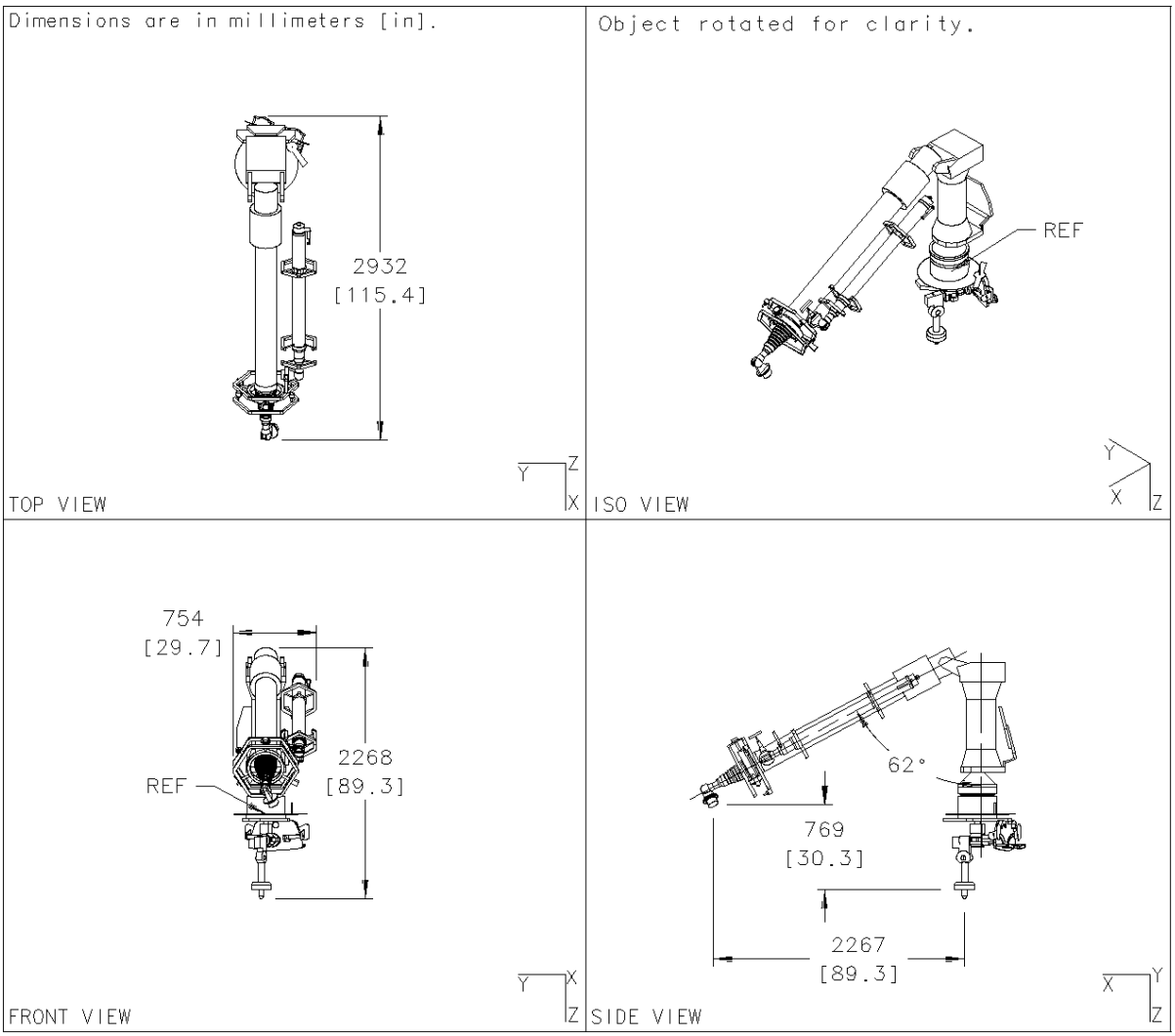
Stage 10A - After Separation 2

Element Properties:

Strela 1

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
N/A	X =	N/A	X =	-23935	-11404	N/A	N/A	N/A
	Y =	N/A	Y =	1150	-4161	N/A	N/A	N/A
	Z =	N/A	Z =	8303	-1156	N/A	N/A	N/A

Reference Point Description: Center of grapple fixture interface plane



STEP 001

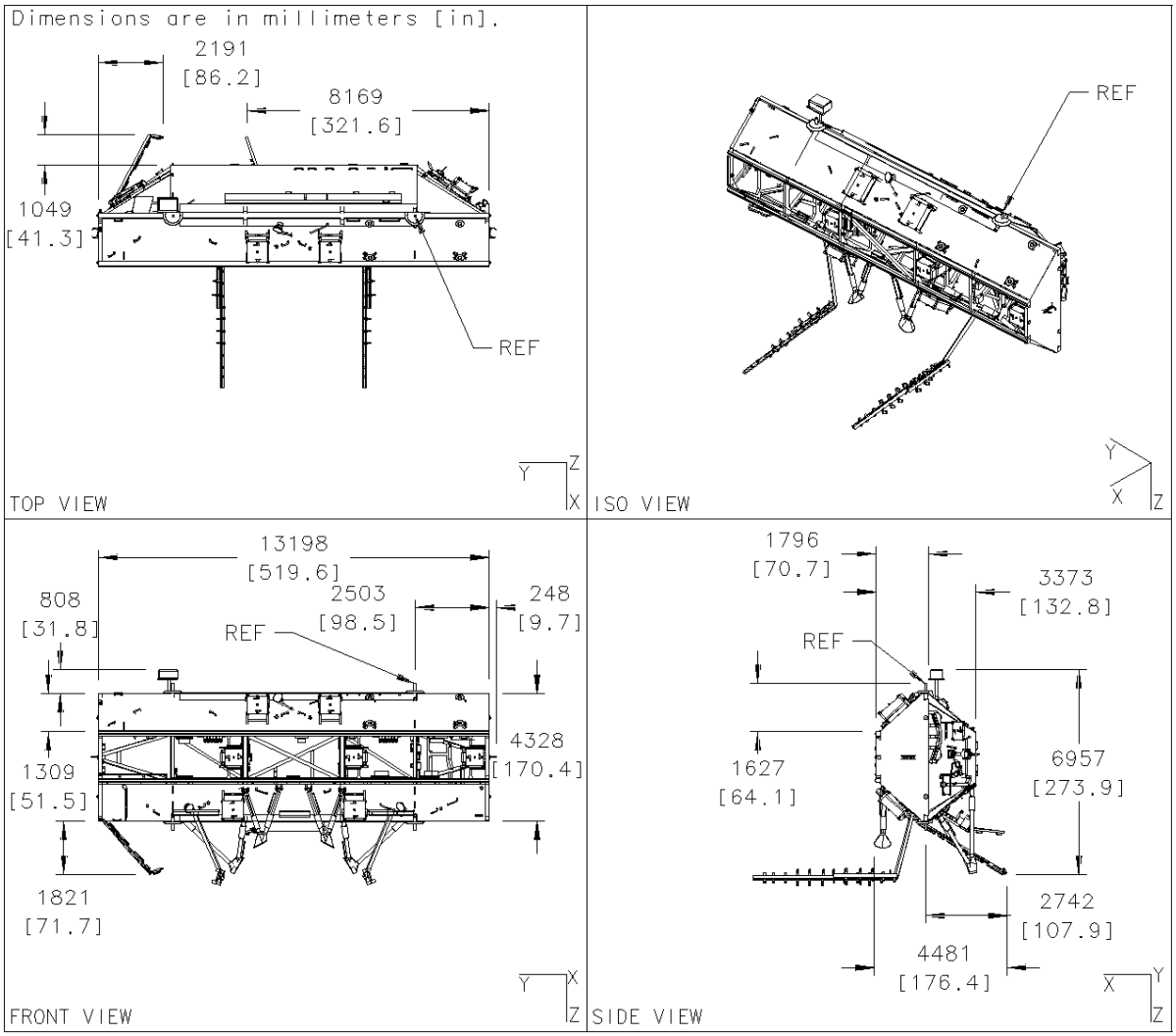
Stage 10A - After Separation 2

Element Properties:

S0 Assembly 8A BS (deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
11314	X =	417	X =	0	-35339	175017	35	-3499
	Y =	-329	Y =	-4096	6625	35	44640	-1559
	Z =	280	Z =	-2483	4090	-3499	-1559	161616

Reference Point Description: Center of port, zenith trunnion pin



STEP 001

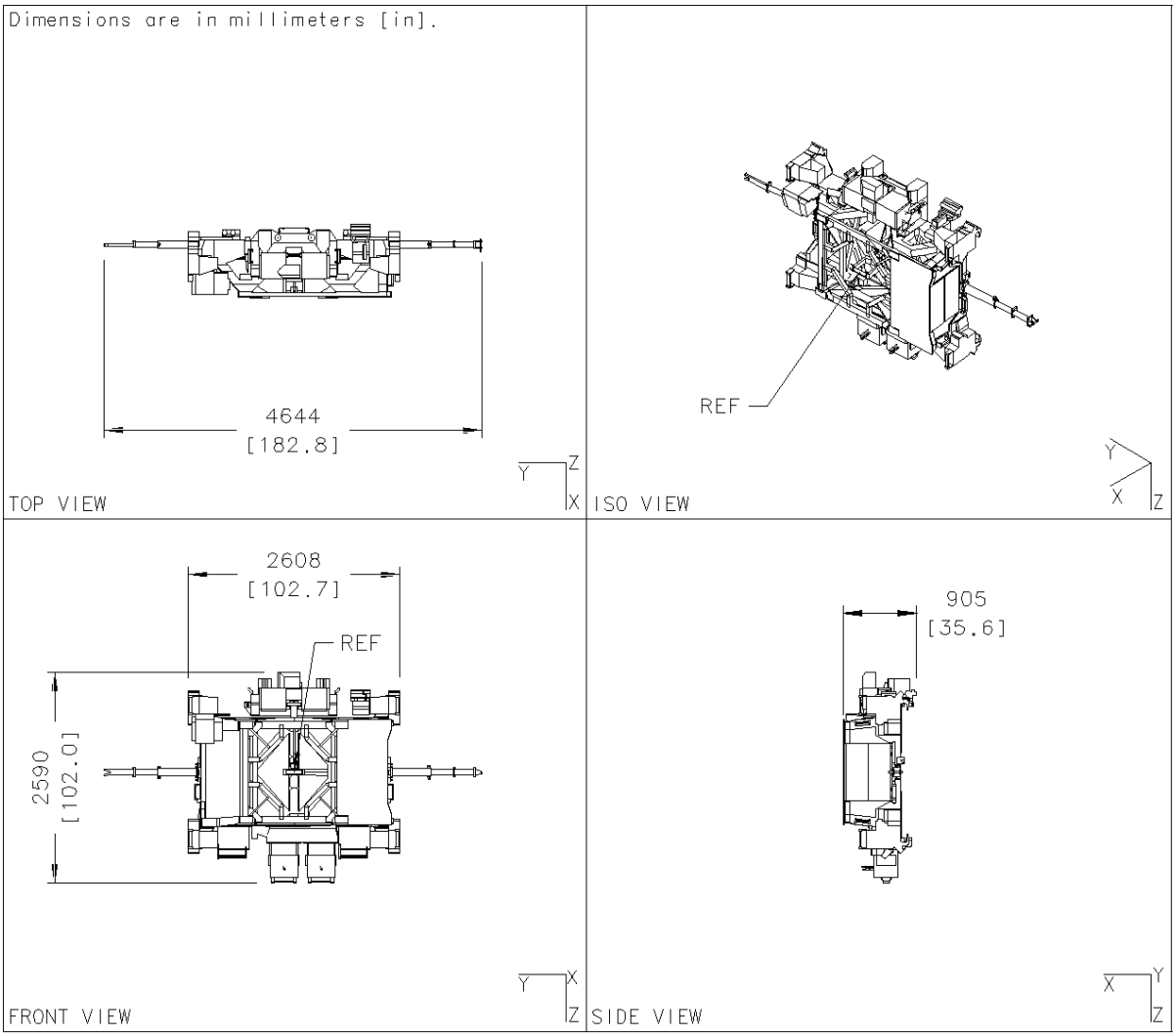
Stage 10A - After Separation 2

Element Properties:

Mobile Transporter at WS#4

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
828	X =	1950	X =	2377	-37716	915	0	0
	Y =	2864	Y =	2864	4142	0	437	0
	Z =	4	Z =	0	-2870	0	0	599

Reference Point Description: Center of the MTSAS



STEP 001

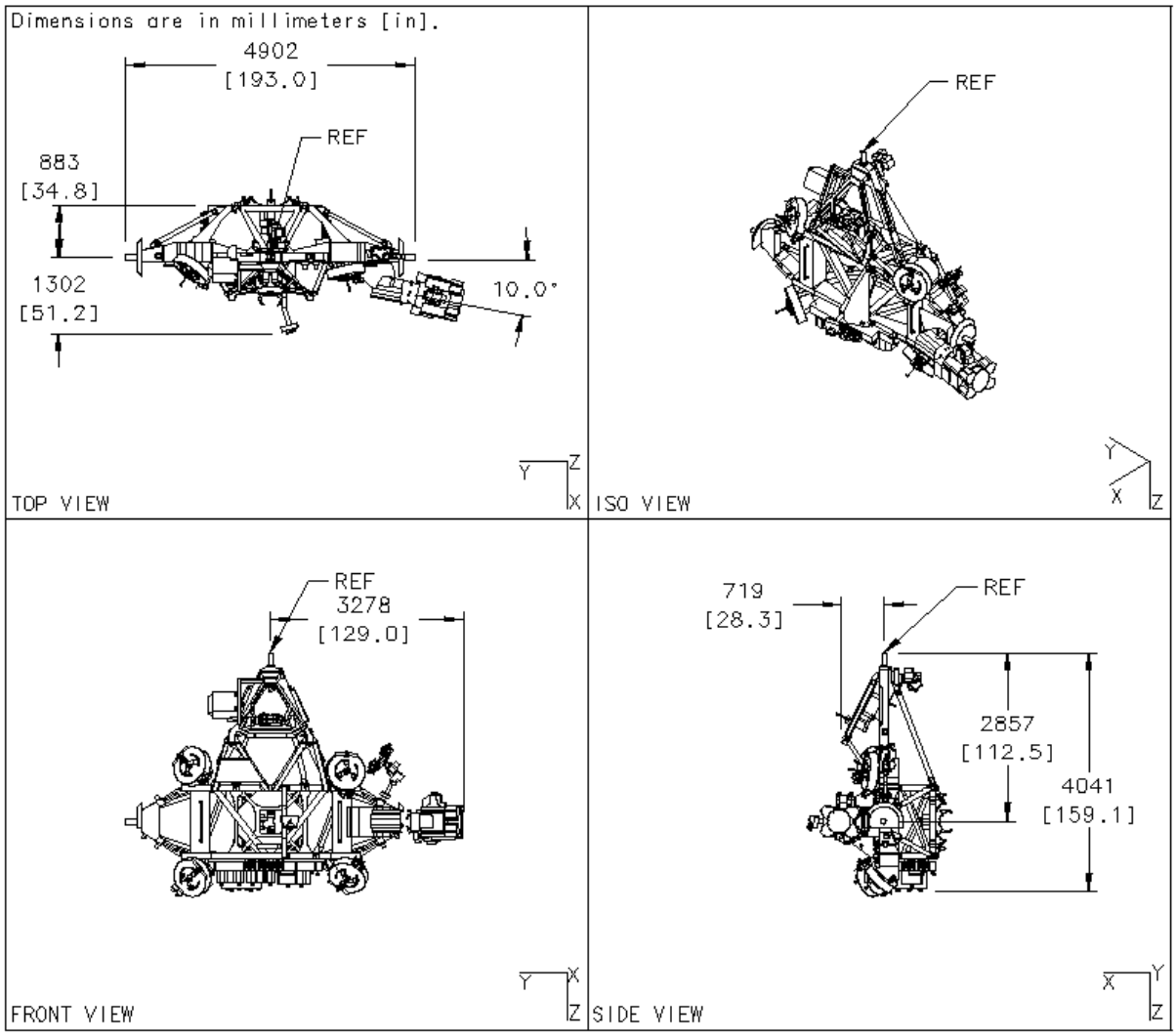
Stage 10A - After Separation 2

Element Properties:

MBS (deployed) at WS#4

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1451	X =	3420	X =	3317	-38656	4085	421	161
	Y =	2476	Y =	2870	7000	421	1608	125
	Z =	-36	Z =	-2858	-2876	161	125	3191

Reference Point Description: Center of the keel pin



STEP 001

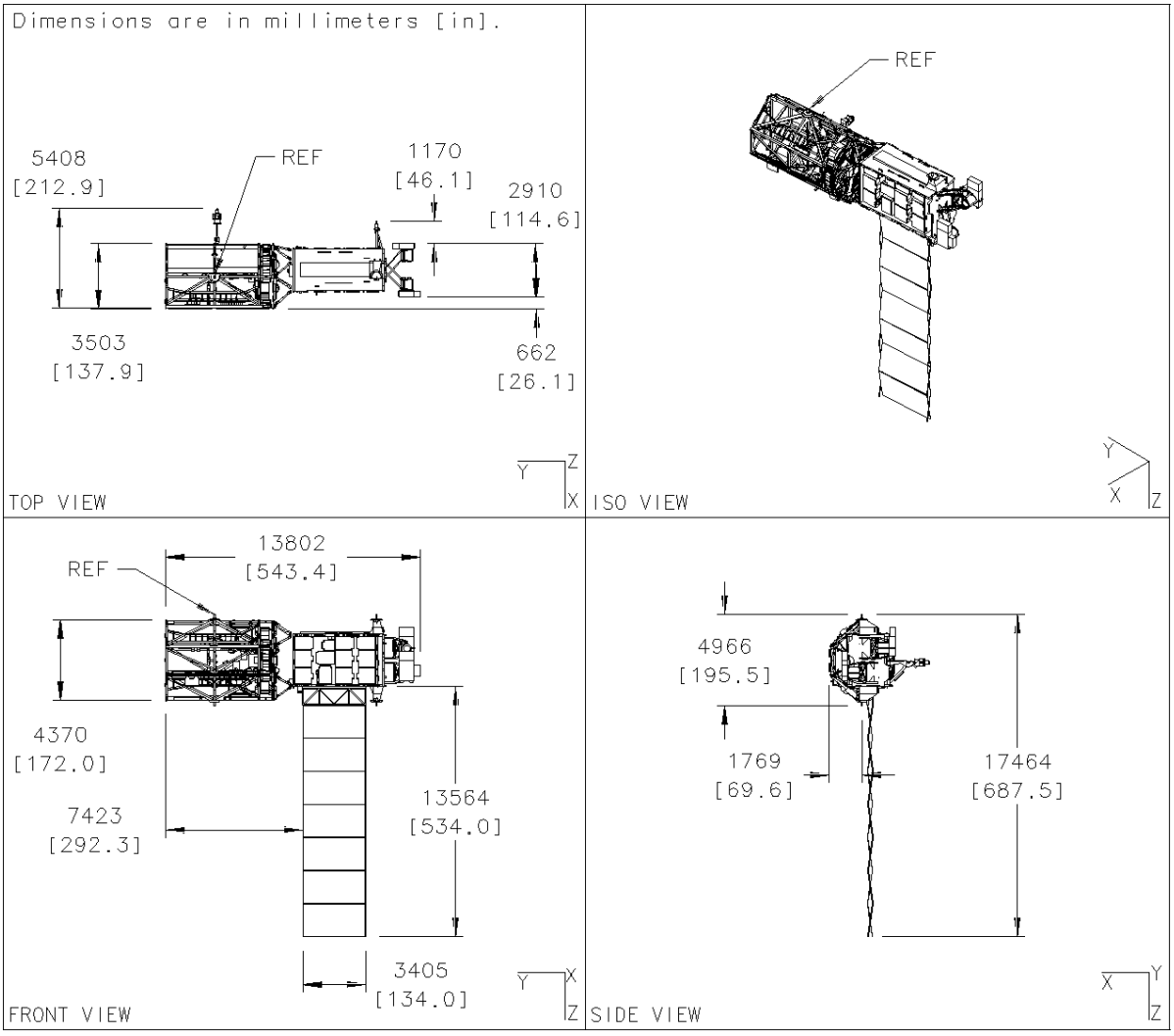
Stage 10A - After Separation 2

Element Properties:

P3/P4 Truss Assembly (deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
13671	X =	396	X =	0	-35339	182077	2773	-1403
	Y =	-28378	Y =	-22994	6625	2773	49438	1786
	Z =	106	Z =	-2483	22988	-1403	1786	150358

Reference Point Description: Center of P3 starboard zenith trunnion pin



STEP 001

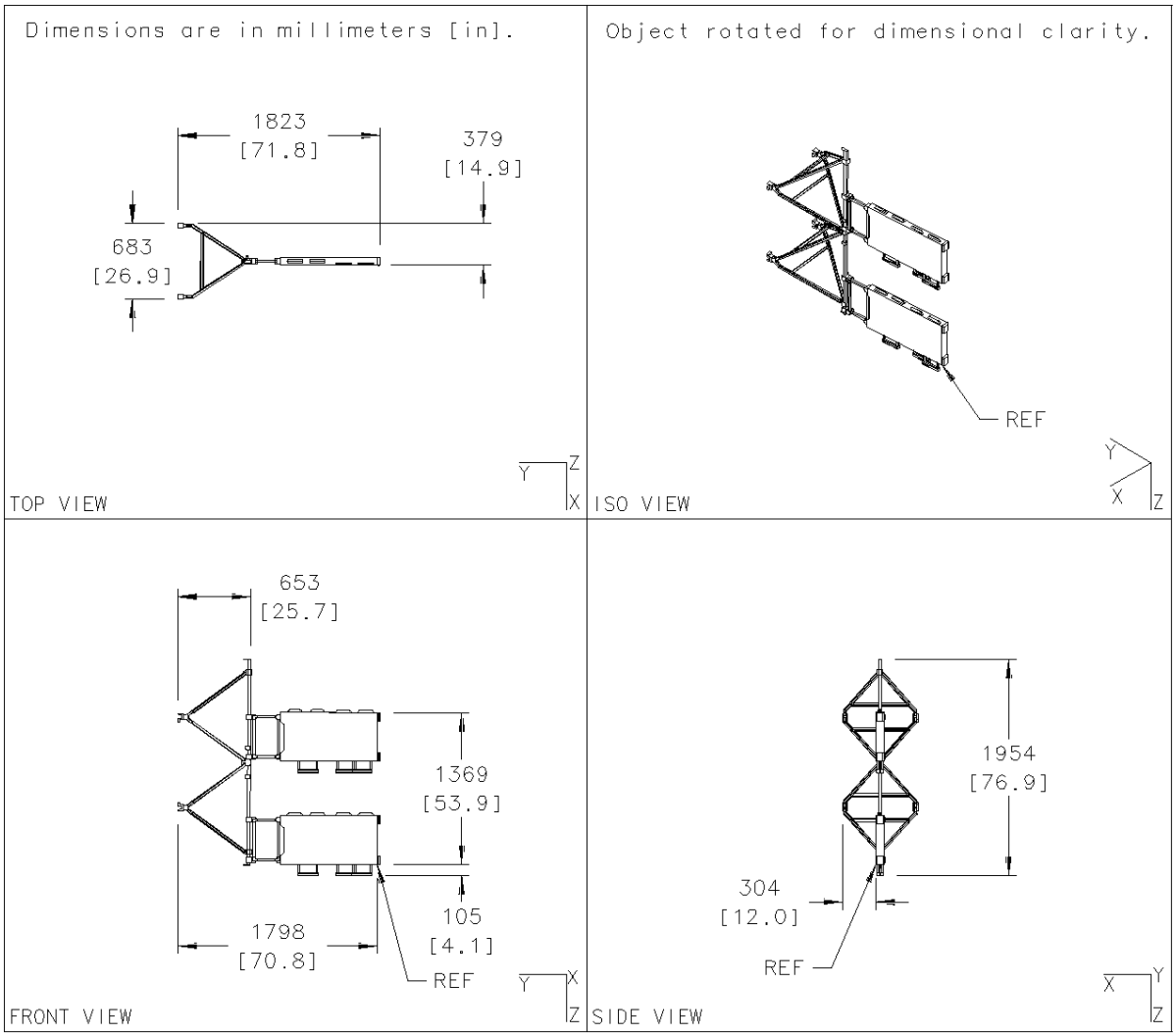
Stage 10A - After Separation 2

Element Properties:

SEEDs 2

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
N/A	X =	N/A	X =	-31625	-3714	N/A	N/A	N/A
	Y =	N/A	Y =	-2316	-3380	N/A	N/A	N/A
	Z =	N/A	Z =	7522	2310	N/A	N/A	N/A

Reference Point Description: Port forward nadir corner of SEEDs 2



STEP 001

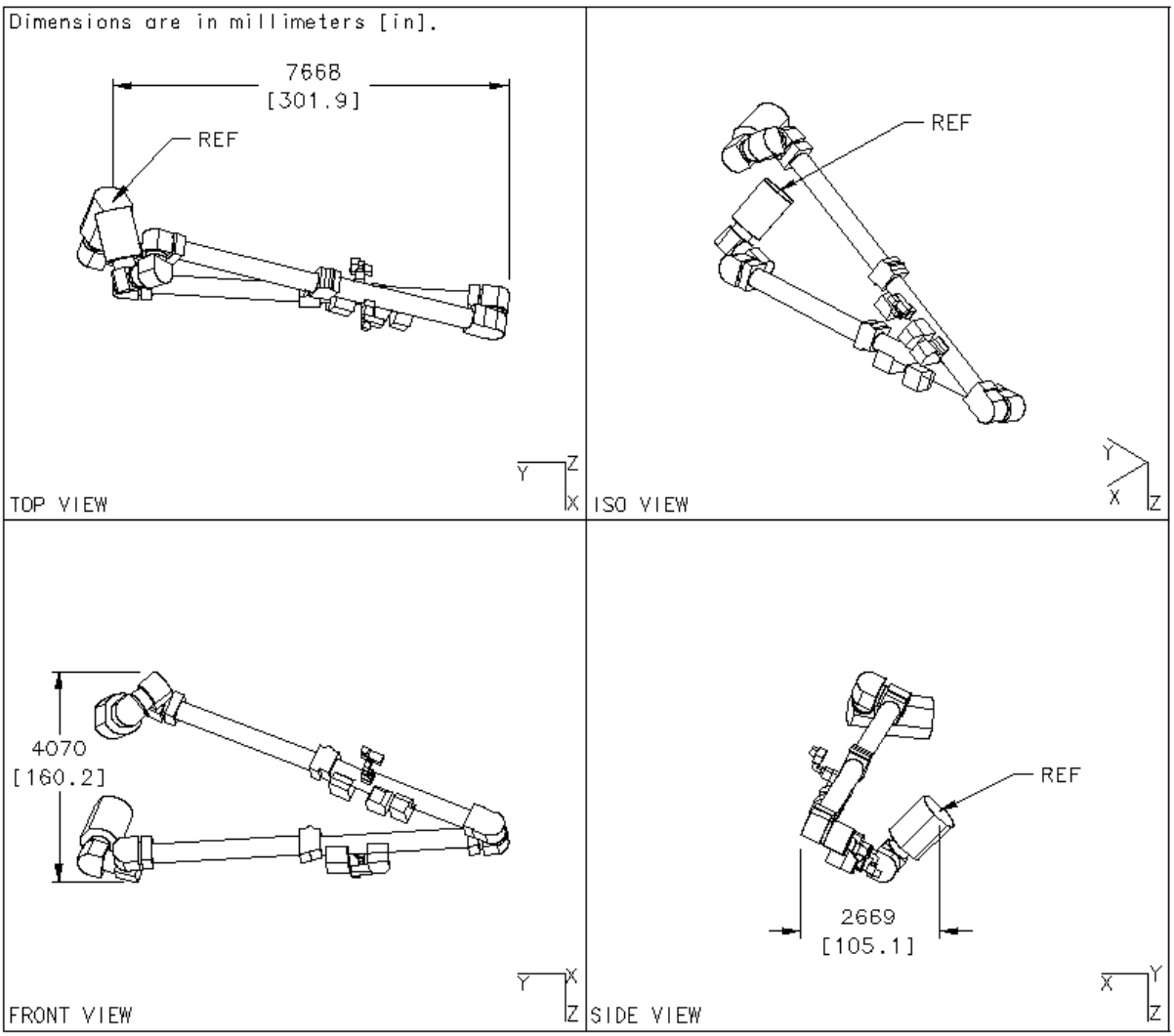
Stage 10A - After Separation 2

Element Properties:

Space Station RMS (relocated from MBS to Destiny)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1502	X =	1938	X =	3482	-38821	13625	3061	639
	Y =	-134	Y =	-1442	-2595	3061	11926	1279
	Z =	9521	Z =	6737	1436	639	1279	6882

Reference Point Description: Center of nadir PDGF interface



STEP 001

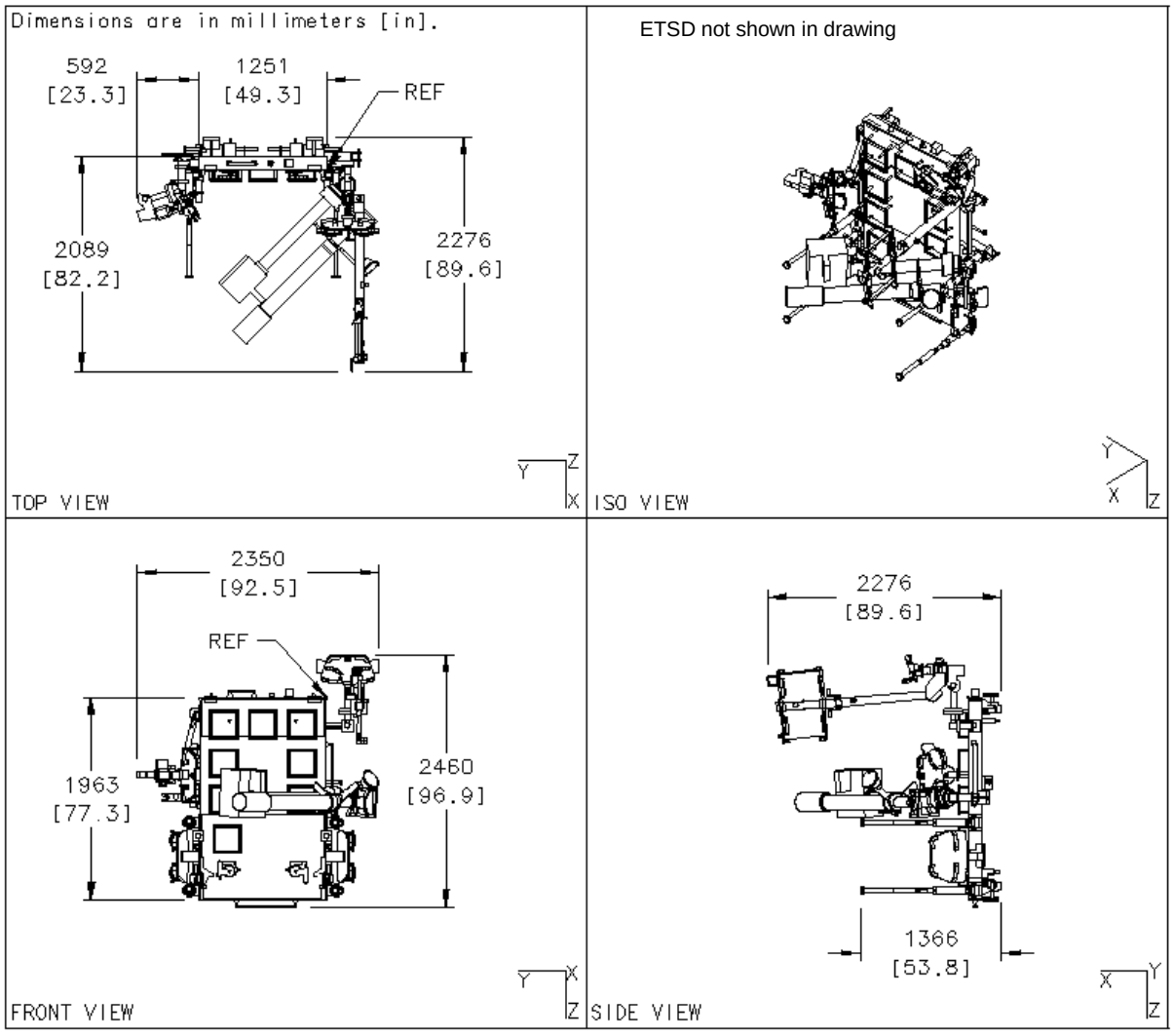
Stage 10A - After Separation 2

Element Properties:

CETA A (with ETSD installed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
353	X =	1987	X =	1921	-37260	261	-6	-21
	Y =	6138	Y =	5454	5110	-6	200	14
	Z =	355	Z =	-968	-5460	-21	14	83

Reference Point Description: Port forward zenith corner of the pallet



STEP 001

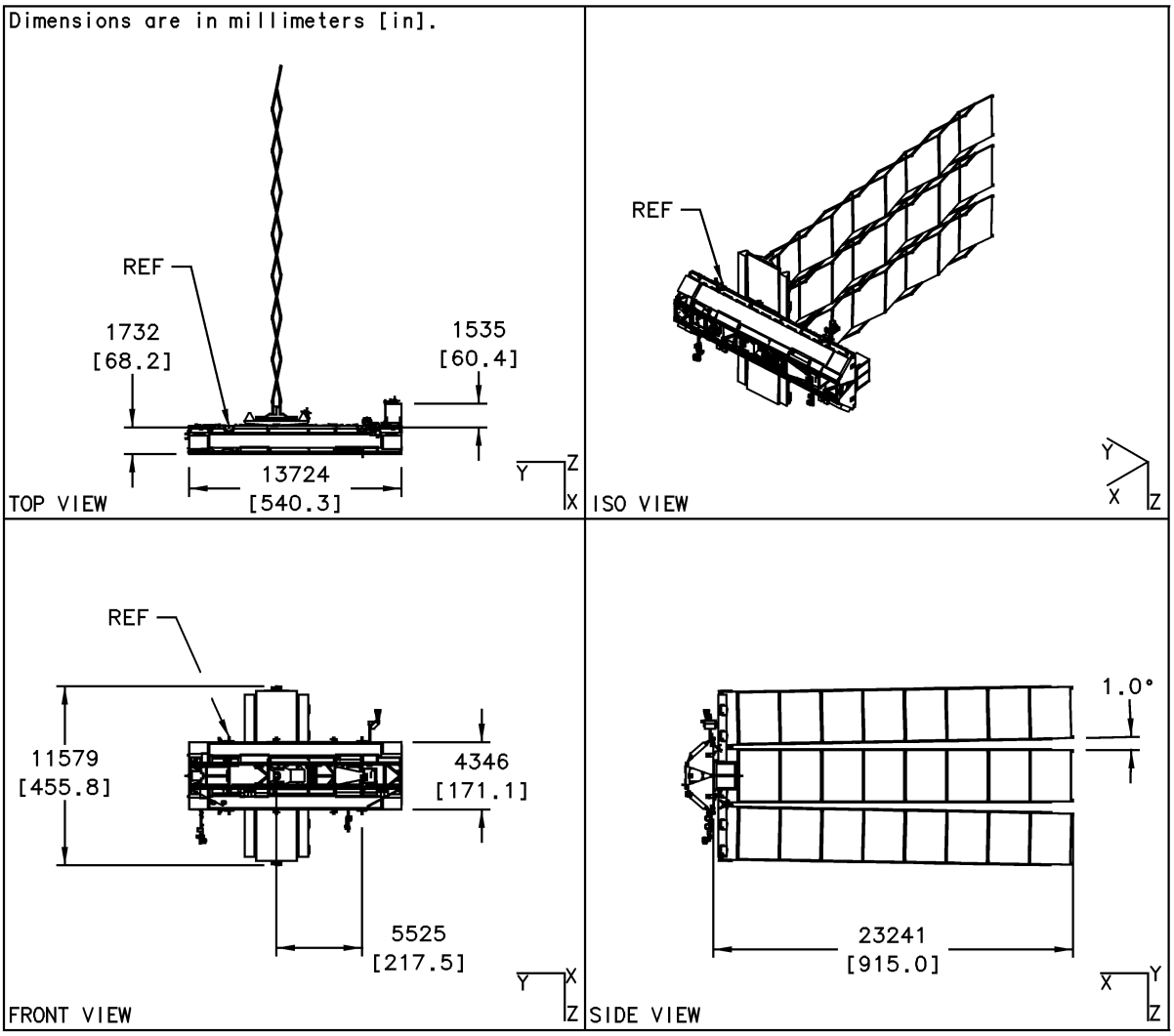
Stage 10A - After Separation 2

Element Properties:

S1 deployed

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
7171	X =	558	X =	0	-35339	145035	-6025	-75
	Y =	12560	Y =	17760	6625	-6025	13961	-3195
	Z =	2	Z =	-2483	-17766	-75	-3195	132405

Reference Point Description: Center of starboard zenith trunnion pin



STEP 001

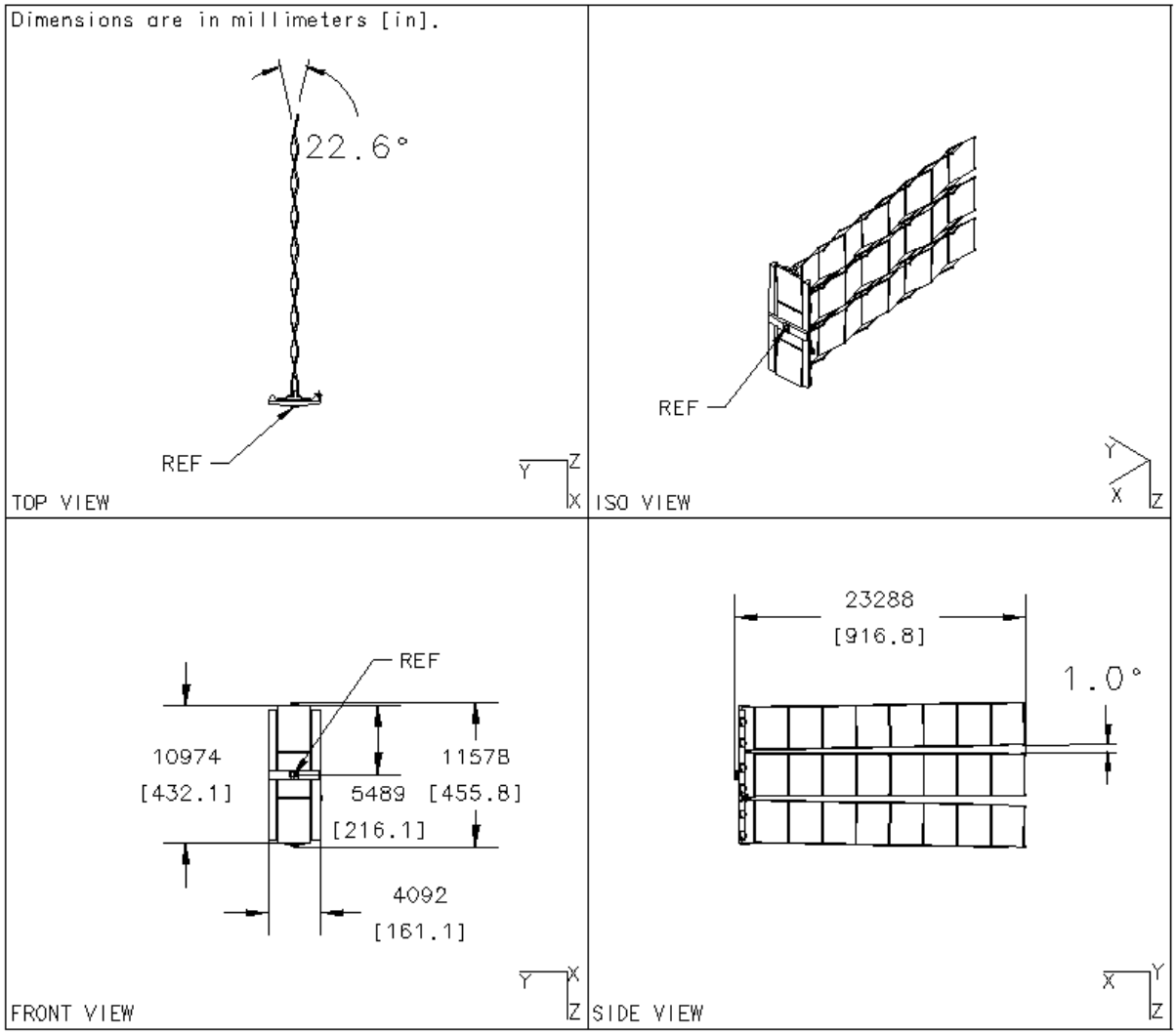
Stage 10A - After Separation 2

Element Properties:

S1 EATCS Radiator and Support (all three panels deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
5196	X =	-5815	X =	-36	-35303	56920	4370	-479
	Y =	14534	Y =	14963	4139	4370	231790	157
	Z =	2	Z =	3	-14969	-479	157	189255

Reference Point Description: Center of the thermal radiator rotary joint



STEP 001

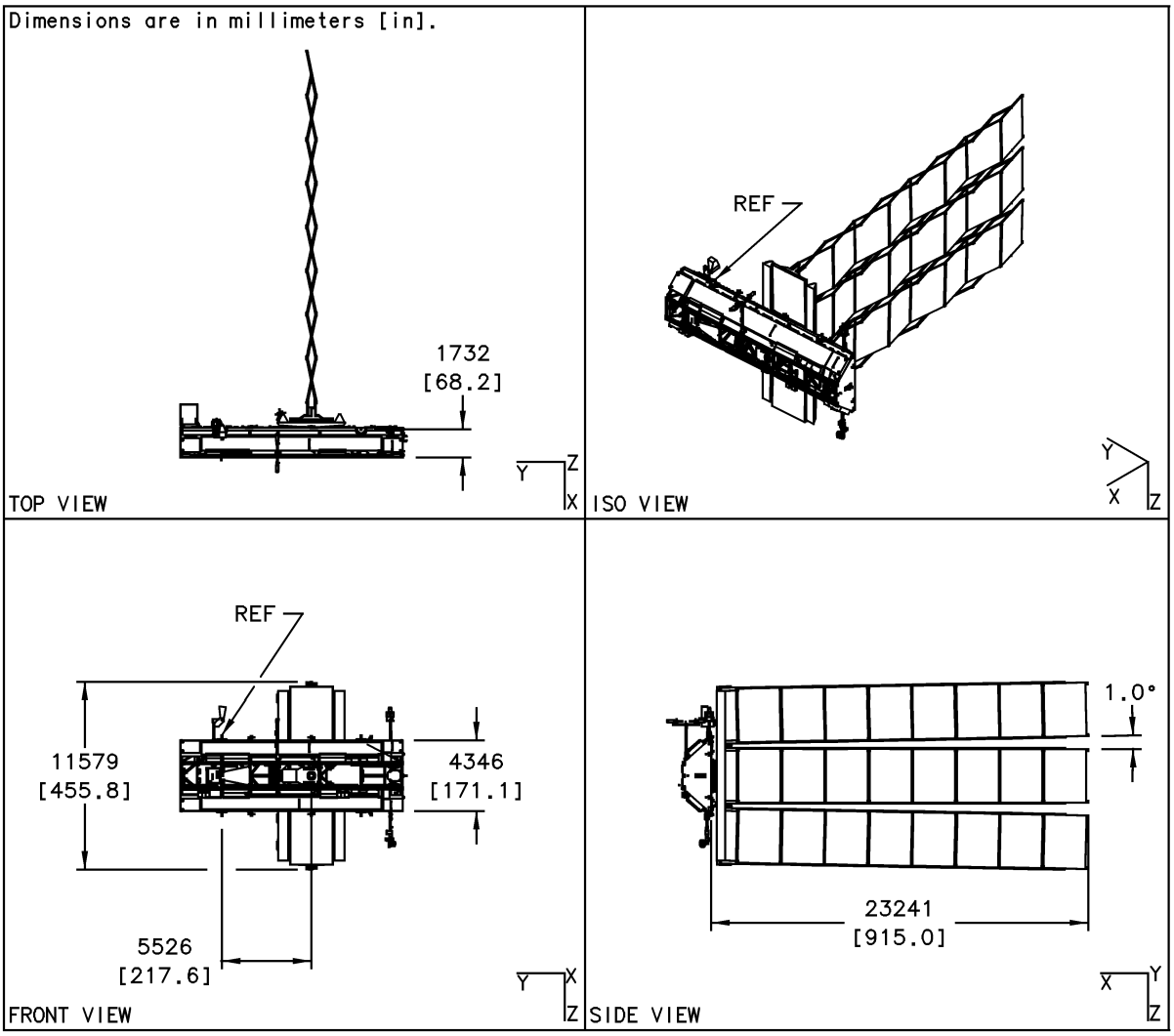
Stage 10A - After Separation 2

Element Properties

P1 deployed

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
7155	X =	591	X =	0	-35339	150658	7064	-213
	Y =	-12587	Y =	-17760	6625	7064	16227	1056
	Z =	-8	Z =	-2483	17754	-213	1056	142325

Reference Point Description: Center of port zenith trunnion pin



STEP 001

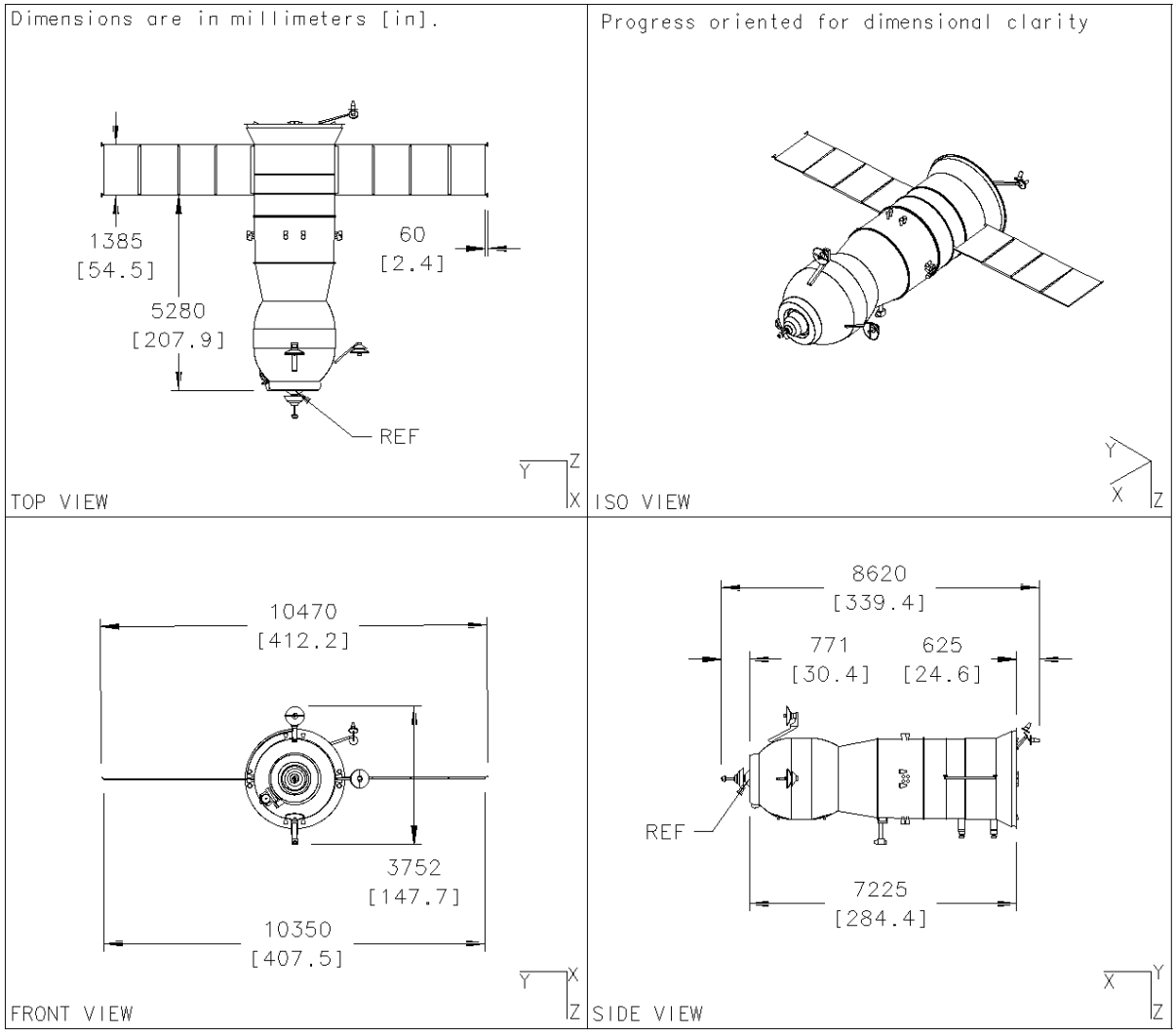
Stage 10A - After Separation 2

Element Properties:

14P Progress (docked to Service Module aft)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
6934	X =	-39609	X =	-35691	352	5194	13	-18
	Y =	13	Y =	-6	0	13	32180	626
	Z =	4143	Z =	4142	0	-18	626	32205

Reference Point Description: Center of forward docking interface plane



STEP 001

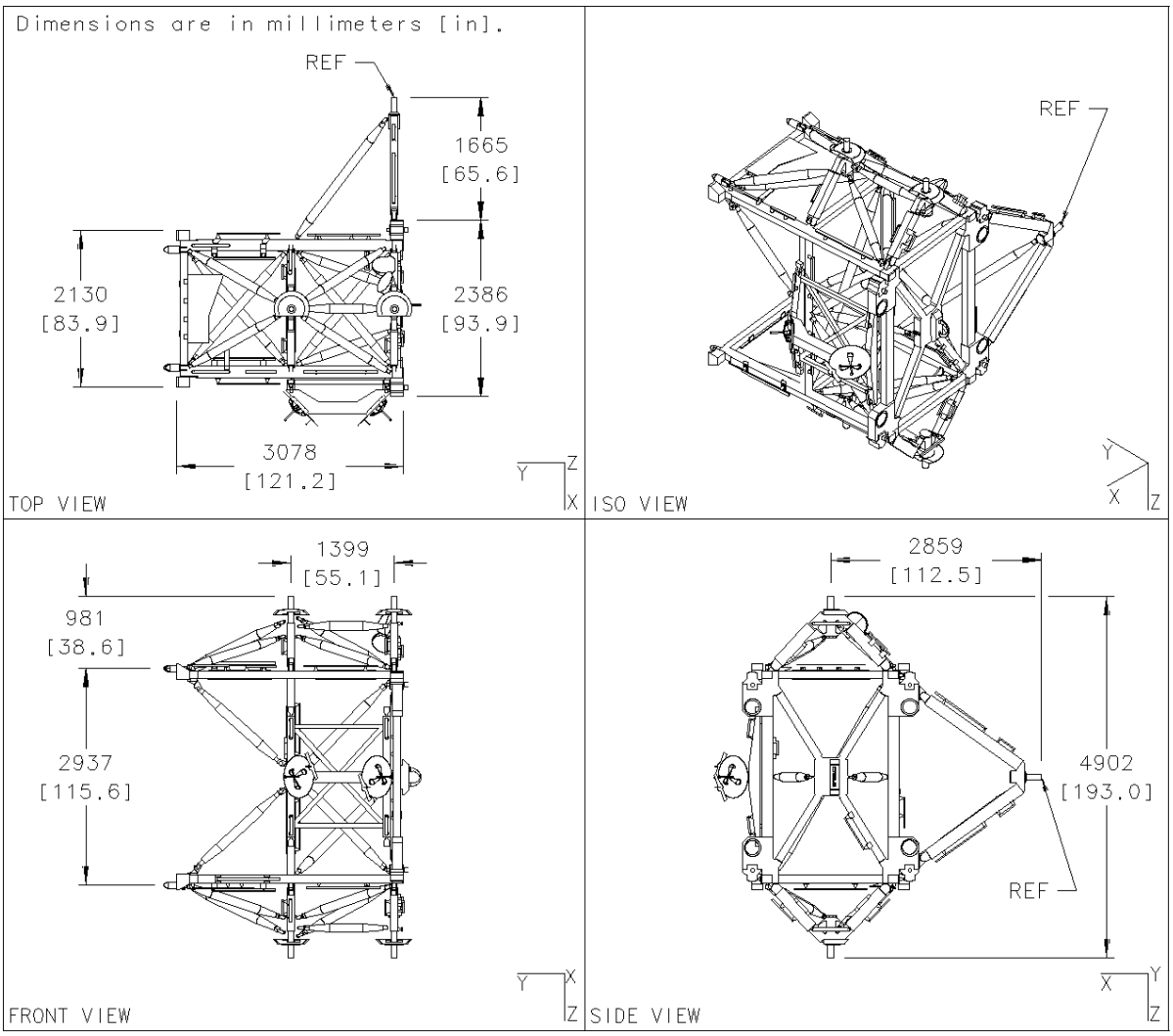
Stage 10A - After Separation 2

Element Properties:

P5 Truss Assembly (includes PVRGF)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1810	X =	-396	X =	-3215	-32124	5085	-81	95
	Y =	-34420	Y =	-35318	4142	-81	4833	-58
	Z =	-20	Z =	0	35312	95	-58	3022

Reference Point Description: Center of keel pin



STEP 001

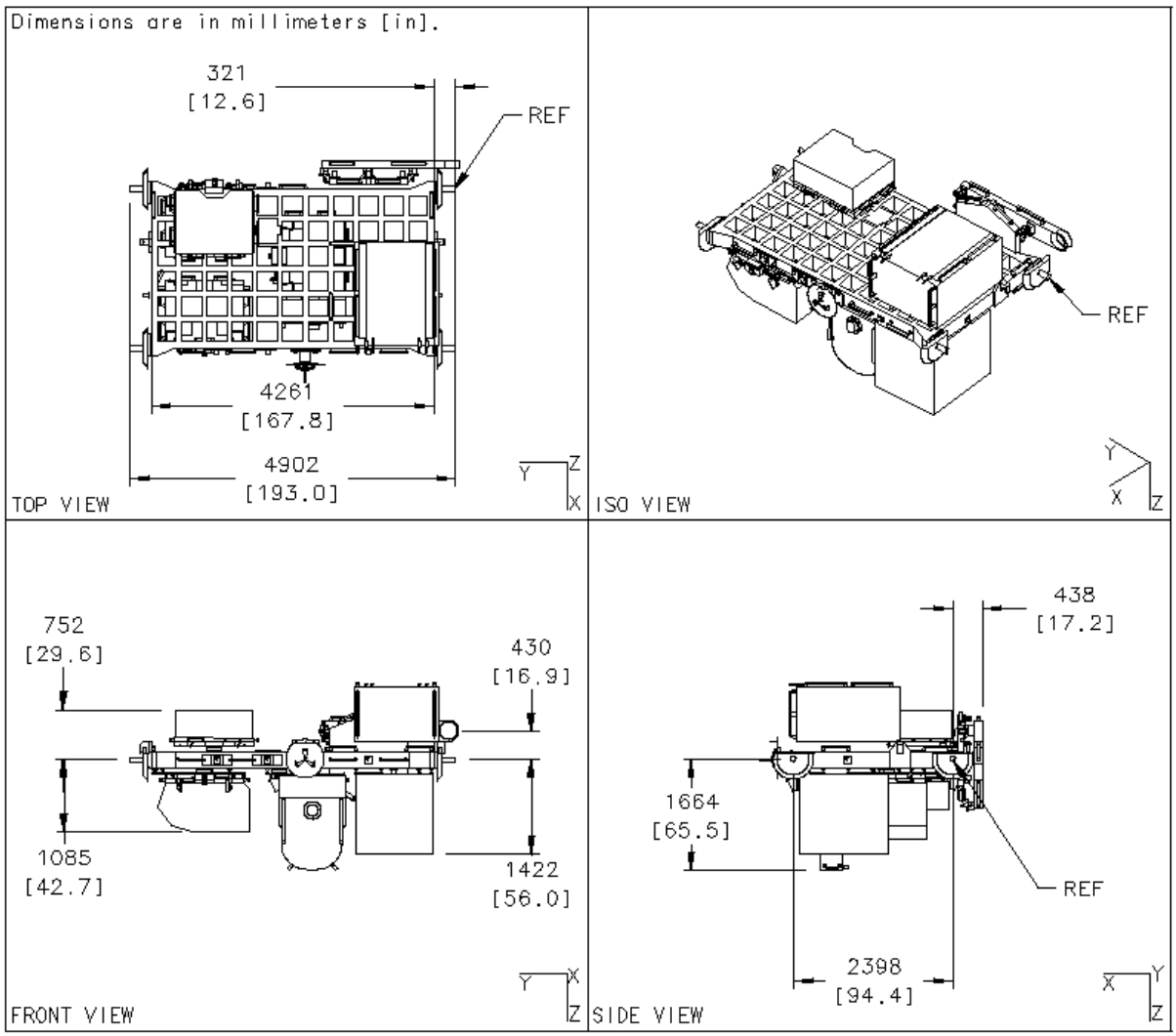
Stage 10A - After Separation 2

Element Properties:

ESP-2 with installed ORUs (wlo VSSA)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
4108	X =	-474	X =	-1698	-33641	8799	309	-107
	Y =	4916	Y =	2734	-1502	309	3690	-305
	Z =	5705	Z =	5644	-2740	-107	-305	9971

Reference Point Description: Center of the port aft trunnion pin



STEP 001

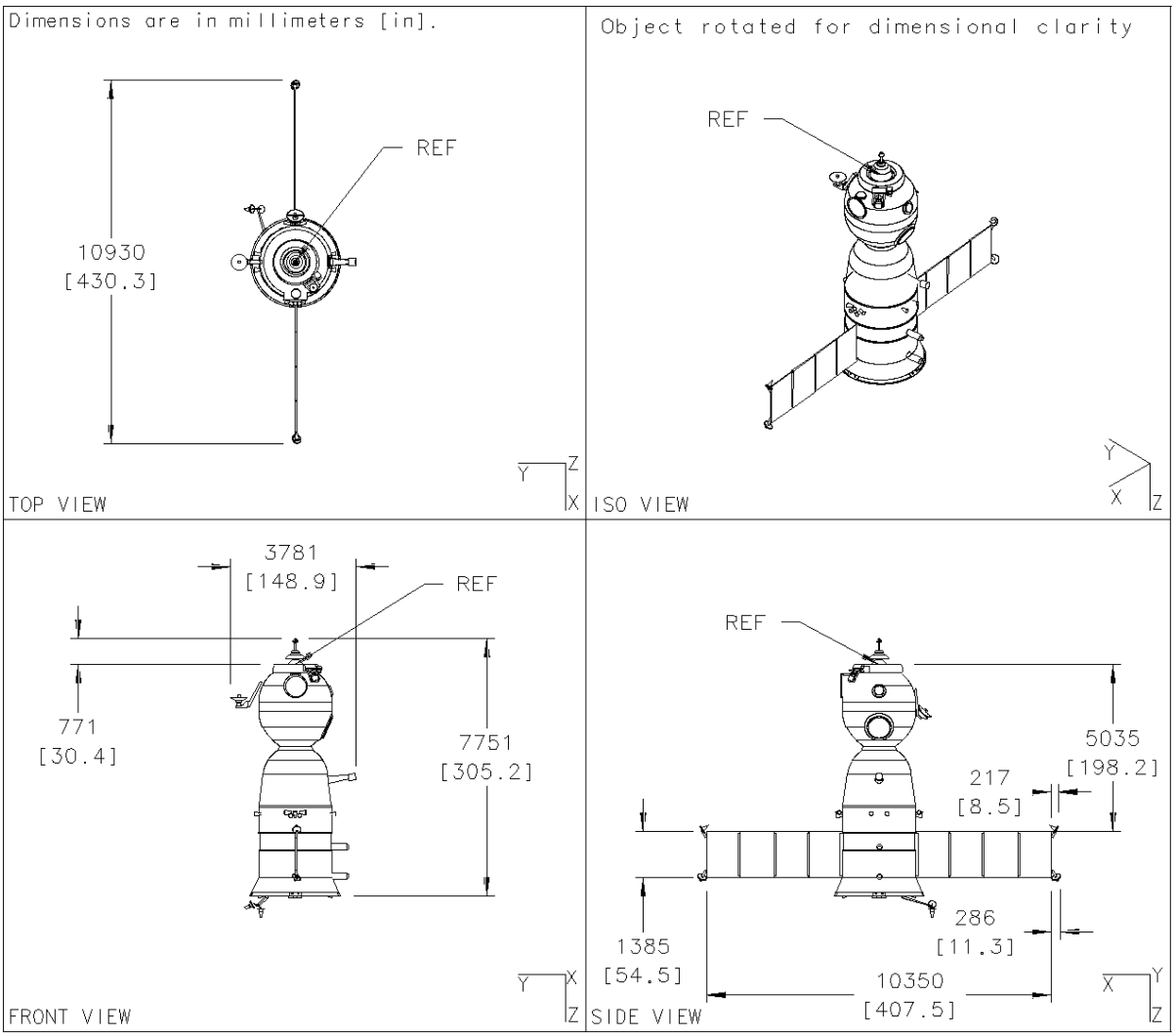
Stage 10A - After Separation 2

Element Properties:

7S Soyuz (docked to Zarya FGB nadir)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
6745	X =	-11120	X =	-11134	-24205	24101	456	4
	Y =	-11	Y =	-6	-1142	456	24100	4
	Z =	9427	Z =	5284	0	4	4	4675

Reference Point Description: Center of zenith docking interface plane



STEP 001

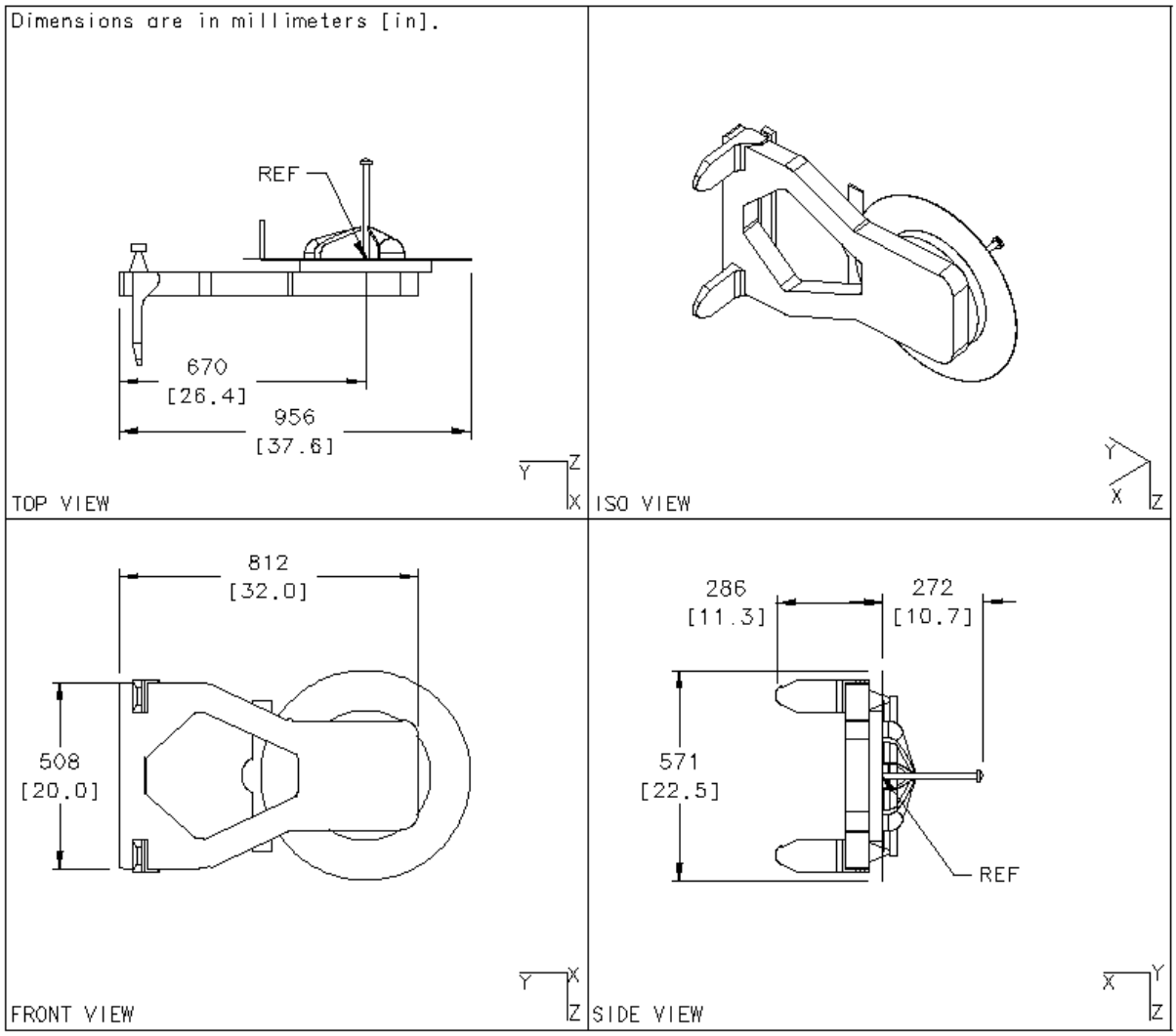
Stage 10A - After Separation 2

Element Properties:

Fixed Grapple Bar (on S1 NH3 Tank)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
34	X =	-1653	X =	-1709	-33630	3	0	0
	Y =	7292	Y =	7053	4136	0	1	0
	Z =	6	Z =	6	-7059	0	0	33

Reference Point Description: Center of Grapple fixture pin base



STEP 001

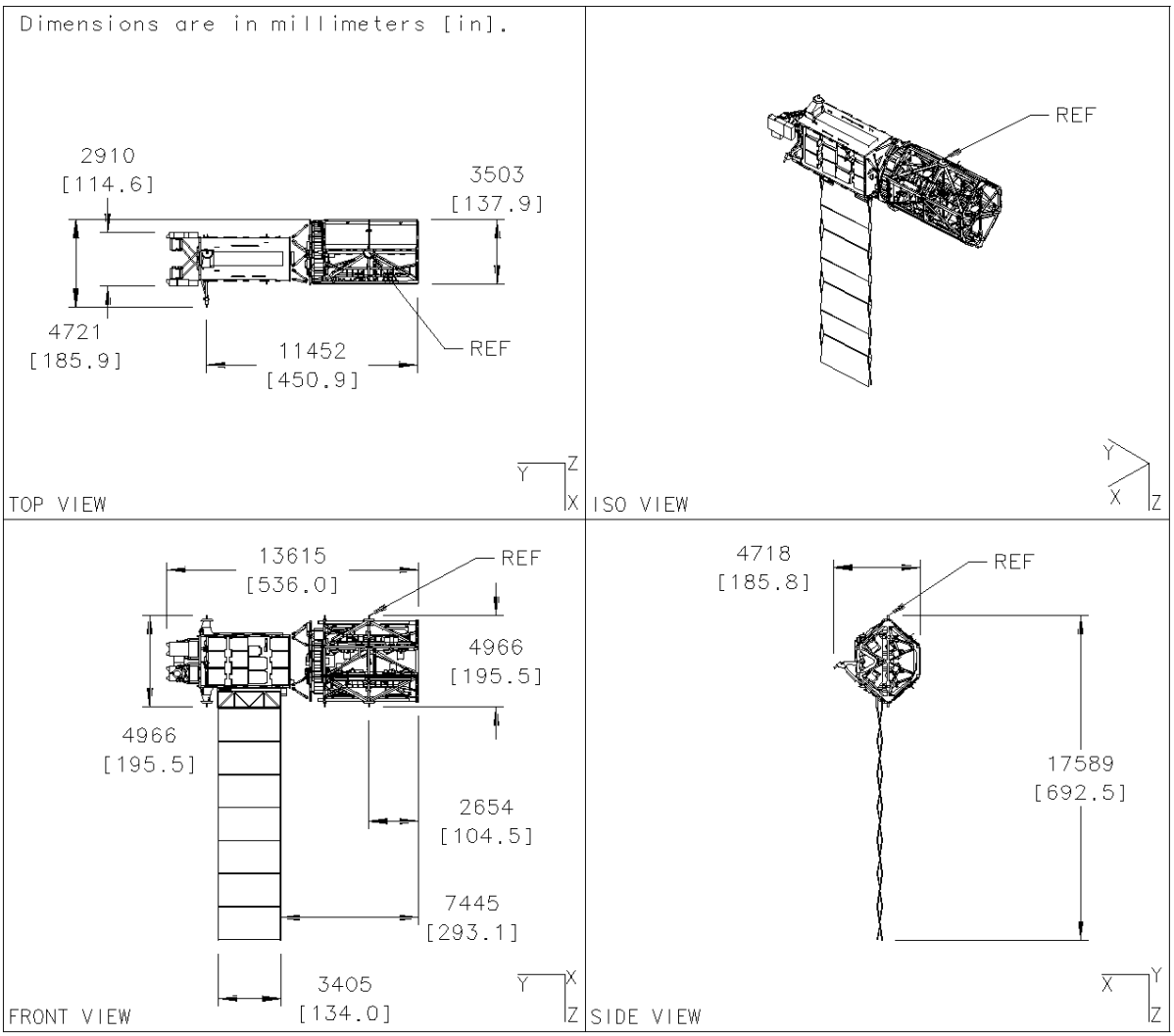
Stage 10A - After Separation 2

Element Properties:

S3/S4 Truss Assembly (deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
13925	X =	294	X =	0	-35339	182321	-4733	5090
	Y =	28330	Y =	22994	6625	-4733	52601	-3876
	Z =	249	Z =	-2483	-23000	5090	-3876	148790

Reference Point Description: Center of S3 port, zenith trunnion pin



STEP 001

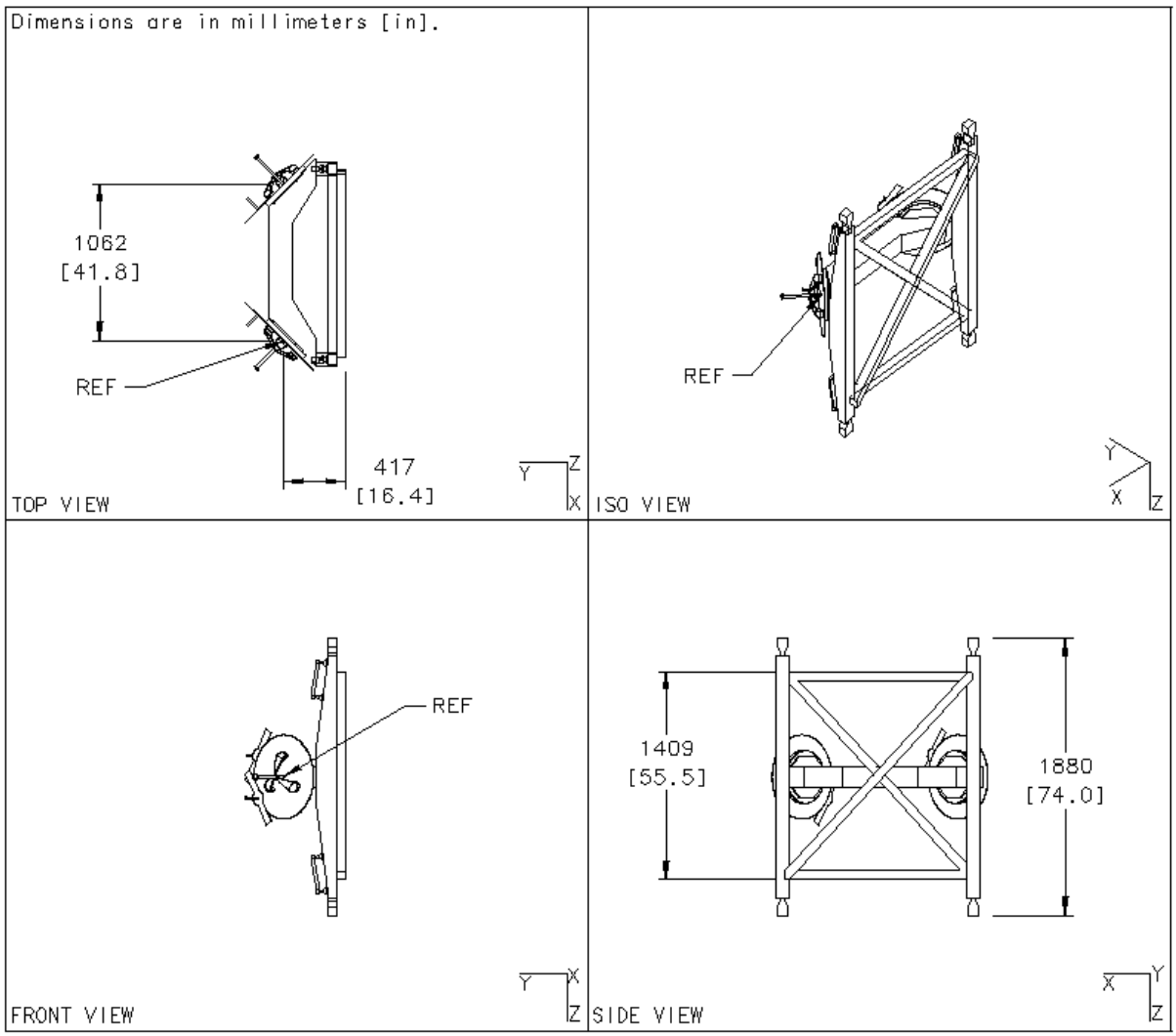
Stage 10A - After Separation 2

Element Properties:

S5 PVRGF (on S5 keel assembly)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
105	X =	2289	X =	2814	-38153	17	0	0
	Y =	35585	Y =	35786	4133	0	41	0
	Z =	8	Z =	9	-35792	0	0	29

Reference Point Description: Forward Grapple Fixture pin base



STEP 001

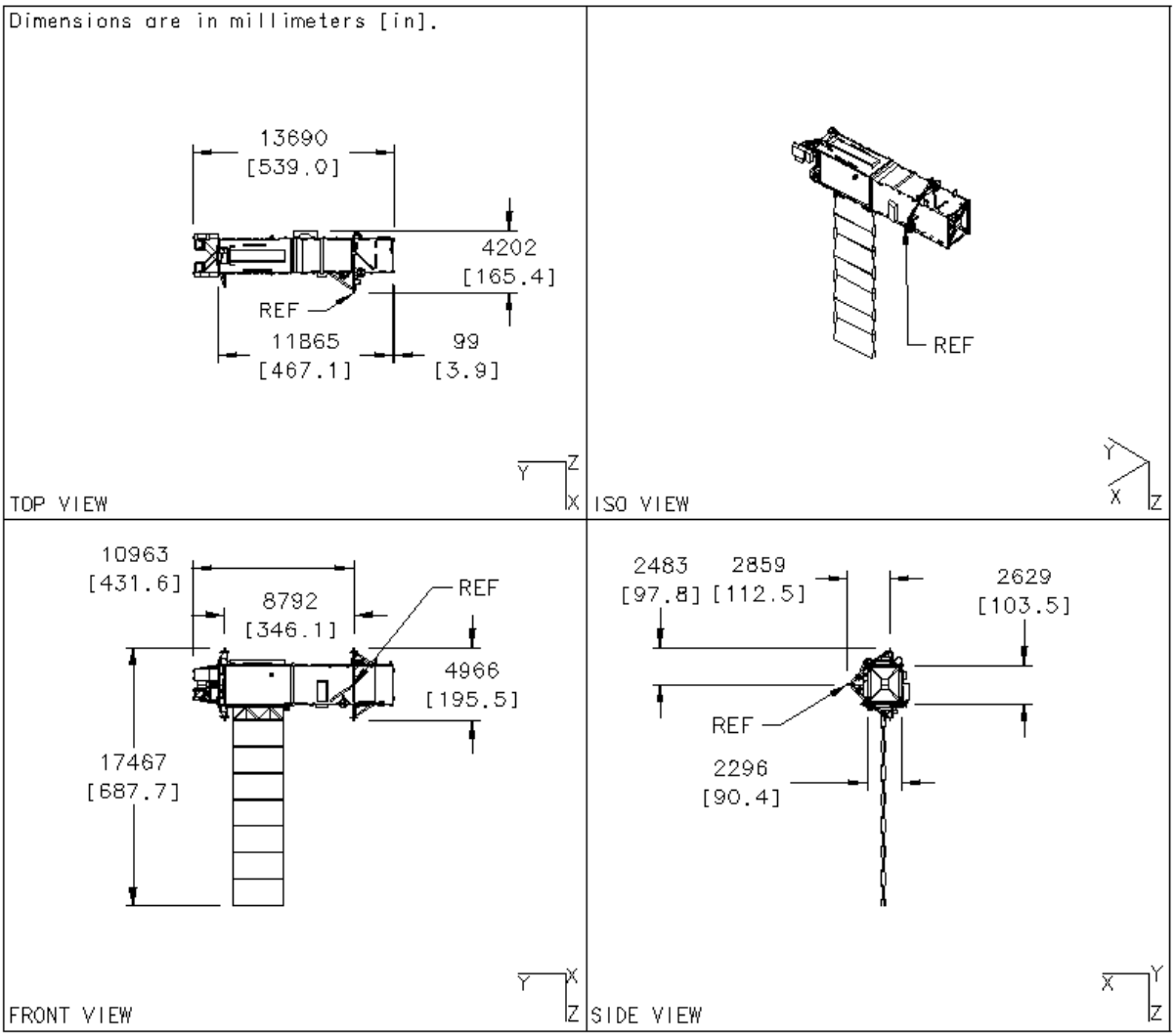
Stage 10A - After Separation 2

Element Properties:

S6 Assembly (with nadir EATCS radiator deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
11777	X =	314	X =	2855	-38194	133583	-519	-1478
	Y =	44305	Y =	38143	4142	-519	45232	469
	Z =	304	Z =	0	-38149	-1478	469	106074

Reference Point Description: Center of the end of forward keel pin



STEP 001

Stage 10A - After Separation 2

Element Properties:

15P Progress (docked to DC1)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
6934	X =	-23701	X =	-23701	-11638	32818	-13	-11
	Y =	-1	Y =	-6	-5166	-13	31566	-36
	Z =	13235	Z =	9308	0	11	-36	5194

Reference Point Description: Center of zenith docking interface plane

Zarya FGB Starboard Array (Deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
250	X =	-15147	X =	-15103	-20236	509	31	-39
	Y =	3565	Y =	1459	0	31	419	-13
	Z =	4161	Z =	4142	-1465	-39	-13	430

Reference Point Description: Center of intersection plane with FGB

Zarya FGB Port Array (Deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
250	X =	-15147	X =	-15103	-20236	509	-31	-39
	Y =	3577	Y =	-1471	0	-31	419	13
	Z =	4161	Z =	4142	1465	-39	13	430

Reference Point Description: Center of interface plane with FGB

Zvezda Service Module Highly Directional (HD) Antenna

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
298	X =	-36194	X =	-35341	2	475	-59	-70
	Y =	1996	Y =	-6	1550	-59	97	28
	Z =	2571	Z =	2592	0	-70	28	424

Reference Point Description: Center of interface plane with Service Module

STEP 001

Stage 10A - After Separation 2

Element Properties:

Zvezda Service Module Starboard Array, deployed

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
580	X =	-27666	X =	-27698	-7641	9436	6	0
	Y =	8086	Y =	1559	0	6	567	0
	Z =	4142	Z =	4142	-1565	0	0	9995

Reference Point Description: Center point of pivot plane

Zvezda Service Module Port Array, deployed

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
580	X =	-27666	X =	-27698	-7641	7965	5	0
	Y =	-8074	Y =	-1570	0	5	484	0
	Z =	4142	Z =	4142	1564	0	0	8442

Reference Point Description: Center point of pivot plane

P6 Solar Array (POF)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1059	X =	13257	X =	1102	-36441	8787	15	-1673
	Y =	-48558	Y =	-48559	3596	15	171792	1
	Z =	705	Z =	546	48553	-1673	1	180359

Reference Point Description: Center of PV mast canister interface with beta gimbal

S6 Solar Array (SOF)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1062	X =	13962	X =	1808	-37147	8811	15	-1677
	Y =	48560	Y =	48559	4917	15	172262	1
	Z =	-615	Z =	-775	-48565	-1677	1	1800853

Reference Point Description: Center of PV mast canister interface with beta gimbal

STEP 001

Stage 10A - After Separation 2

Element Properties:

S6 Solar Array (SOA)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1062	X =	-13257	X =	-1102	-34237	8811	15	1677
	Y =	48558	Y =	48559	3596	15	172262	-1
	Z =	705	Z =	546	-48565	1677	-1	180853

Reference Point Description: Center of PV mast canister interface with beta gimbal

P6 Forward Radiator (stowed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
744	X =	1149	X =	N/A	N/A	1043	-3	-1
	Y =	-38527	Y =	N/A	N/A	-3	249	5
	Z =	42	Z =	N/A	N/A	-1	5	837

Reference Point Description:

P6 Nadir Radiator (deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
731	X =	-375	X =	N/A	N/A	14346	-3	149
	Y =	-44564	Y =	N/A	N/A	-3	13601	174
	Z =	4611	Z =	N/A	N/A	149	174	940

Reference Point Description: N/A

P1 EATCS Radiator and Support (all three panels deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
5196	X =	-5815	X =	-36	-35303	56920	-4370	479
	Y =	-14534	Y =	-14693	4139	-4370	231790	157
	Z =	-2	Z =	3	14687	479	157	189255

Reference Point Description: Center of the thermal radiator rotary joint

STEP 001

Stage 10A - After Separation 2

Element Properties:

CETA Cart B

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
221	X =	1881	X =	1921	-37260	122	0	0
	Y =	-351	Y =	-970	5110	0	77	0
	Z =	51	Z =	-968	964	0	0	47

Reference Point Description: Port forward zenith corner

P4 Radiator (deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
731	X =	-380	X =	N/A	N/A	14427	-4	150
	Y =	-29402	Y =	N/A	N/A	-4	13702	195
	Z =	4668	Z =	N/A	N/A	150	195	915

Reference Point Description: N/A

P4 PIF Solar Array

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1074	X =	13252	X =	1098	-36437	8911	16	-1696
	Y =	-33417	Y =	-33419	3596	16	174208	1
	Z =	705	Z =	546	33413	-1696	1	182896

Reference Point Description: Center of PV mast canister interface with beta gimbal

P4 PIA Solar Array

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1074	X =	-13966	X =	-1812	-33527	8911	16	1696
	Y =	-33420	Y =	-33419	4917	16	174208	-1
	Z =	-616	Z =	-775	33413	1696	-1	182896

Reference Point Description: Center of PV mast canister interface with beta gimbal

STEP 001

Stage 10A - After Separation 2

Element Properties:

S4 SIFSolar Array

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
	X =	13966	X =	1812	-37151	8911	16	-1696
1074	Y =	33391	Y =	33390	4917	16	174208	1
	Z =	-615	Z =	-775	-33396	-1696	1	182896

Reference Point Description: Center of PV mast canister interface with beta gimbal

S4 SIA Solar Array

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
	X =	-13252	X =	-1098	-34241	8911	16	1696
1074	Y =	33389	Y =	33390	3596	16	174208	-1
	Z =	705	Z =	546	-33396	1696	-1	182896

Reference Point Description: Center of PV mast canister interface with beta gimbal

S4 Radiator (relocated from P6 aft to S4 nadir - deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
	X =	38	X =	N/A	N/A	14684	-4	-152
744	Y =	29402	Y =	N/A	N/A	-4	13946	-198
	Z =	4794	Z =	N/A	N/A	-152	-198	932

Reference Point Description: N/A

S5 Truss Assembly (PVRGF on S5 keel)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
	X =	56	X =	3215	-38554	5200	-173	169
1905	Y =	34475	Y =	35318	4142	-173	5044	-98
	Z =	-2	Z =	0	-35324	169	-98	3349

Reference Point Description: Center of keel pin

STEP 001

Stage 10A - After Separation 2

Element Properties:

S6 Beta Gimbals (Deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
851	X =	353	X =	N/A	N/A	530	0	571
	Y =	48302	Y =	N/A	N/A	0	1532	0
	Z =	-5	Z =	N/A	N/A	571	0	1303

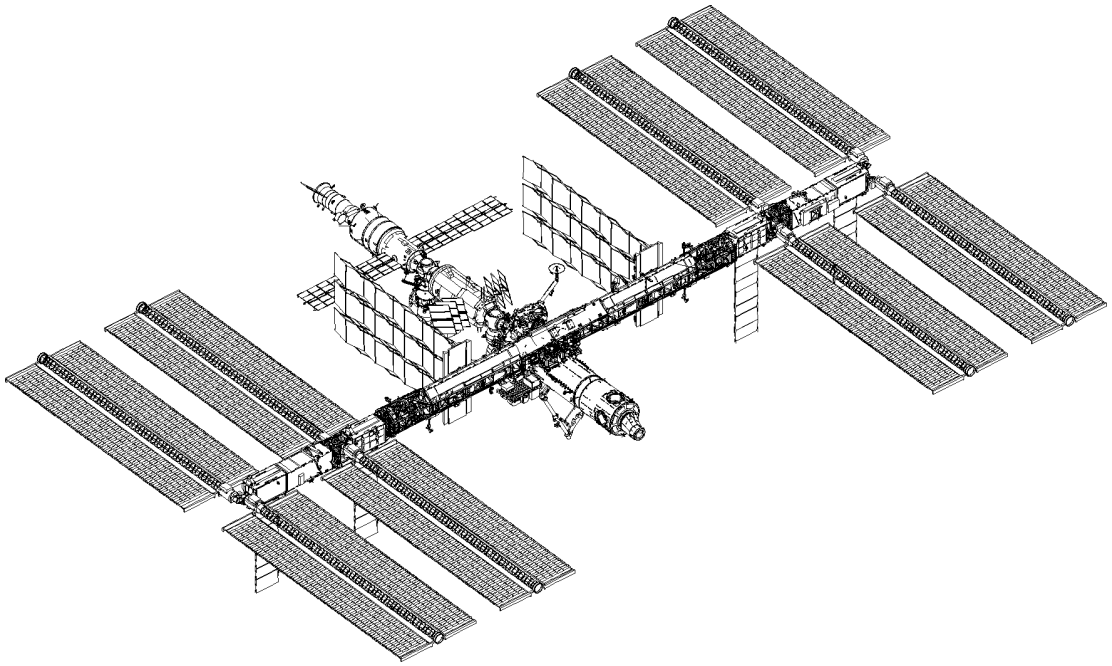
Reference Point Description: N/A

S6 Radiator (nadir, deployed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
744	X =	375	X =	N/A	N/A	14601	-3	-152
	Y =	44564	Y =	N/A	N/A	-3	13843	-178
	Z =	4611	Z =	N/A	N/A	-152	-178	956

Reference Point Description: N/A

Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 001		
M. Falou/LM/281-333-6326	Stage 10A ISS – After Separation 2		
Produced By	Contract		Item Number
Theresa Tran	NAS9-19100 Science Engineering Analysis & Test		03-DR0007
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	6/30/03



Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 001		
M. Falou/LM/281-333-6326	Stage 10A ISS – After Separation 2		
Produced By	Contract		Item Number
Theresa Tran	NAS9-19100 Science Engineering Analysis & Test		03-MP0032
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/13/03

```
Total mass:              559791. lb
                         253917. kg

Center of mass:
                            X           Y           Z
                         -22.06         .26       10.10 ft
                          -6.72         .08        3.08 m

Inertia tensor*:
                                    slug*ft**2
                       72340032.    -330470.    2664991.
                        -330470.   33501666.    -221526.
                        2664991.    -221526.  101619184.

                                     kg*m**2
                       98079872.    -448058.    3613240.
                        -448058.   45422140.    -300349.
                        3613240.    -300349.  137777056.

Principal moments of inertia (IXX, IYY, IZZ):
                       72099706.   33497845.  101858160. slug*ft**2
                       97757064.   45418368.  138105344. kg*m**2

Principal to body roll, pitch, yaw in a 1 2 3 sequence:
                            -.17       -5.16         .46 degrees

Center of pressure:
(WRT CM)                      X ft        Y ft        Z ft
                    CPx    .00E+00    -1.23E-01    3.04E-01
                    CPy  -1.55E+01      .00E+00   -1.17E+00
                    CPz   1.60E+01    -8.59E-01     .00E+00

                              X m         Y m         Z m
                    CPx    .00E+00    -3.75E-02    9.27E-02
                    CPy  -4.72E+00      .00E+00   -3.55E-01
                    CPz   4.87E+00    -2.62E-01     .00E+00

Projected areas:
                            X           Y           Z
                         7456.12     5069.66    32039.65 ft**2
                          692.70      470.99     2976.58 m**2

*Off-diagonal elements are negative integrals
```

STEP 002

Stage 1E – After Separation

- The Columbus module is installed on the Node 2 starboard CBM.
- Two external payloads are added to the Columbus module starboard zenith payload pallet.
- Prior to this stage, the Automated Transfer Vehicle (ATV) visited the ISS docking to Service Module aft docking port and then departed.

STEP 002

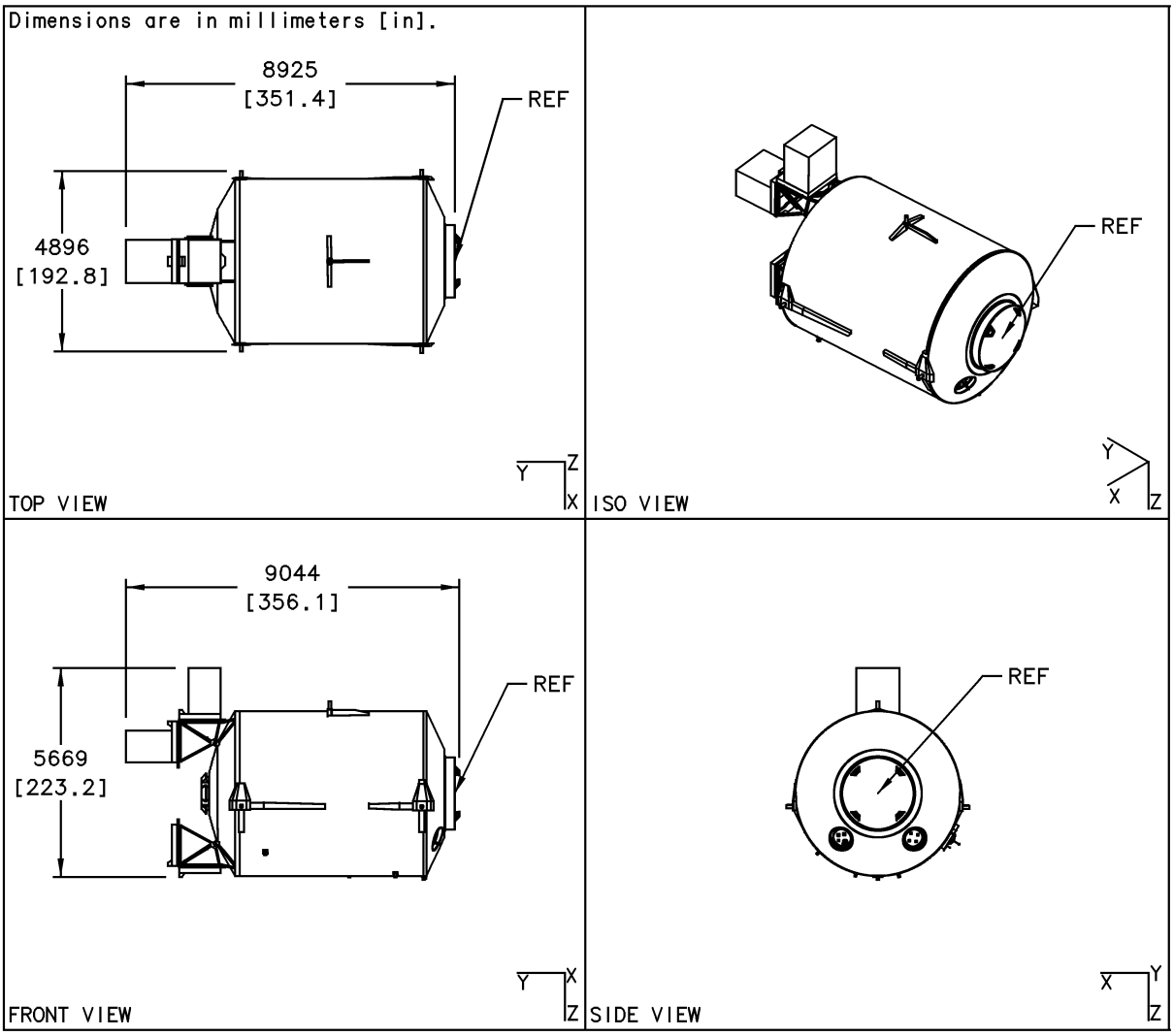
Stage 1E – After Separation

Element Properties:

ESA Columbus Module (with two Payloads)

Mass	Center of Mass		Reference Point			Inertia Tensor		
[kg]	[mm]		ISS [mm]	RSA [mm]		[kg*m^2]		
16809	X =	10673	X =	10934	-46273	104153	-1088	83
	Y =	5713	Y =	2007	-719	-1088	49736	5457
	Z =	4755	Z =	4861	-2013	83	5457	102651

Reference Point Description: Center of port CBM interface plane



STEP 002

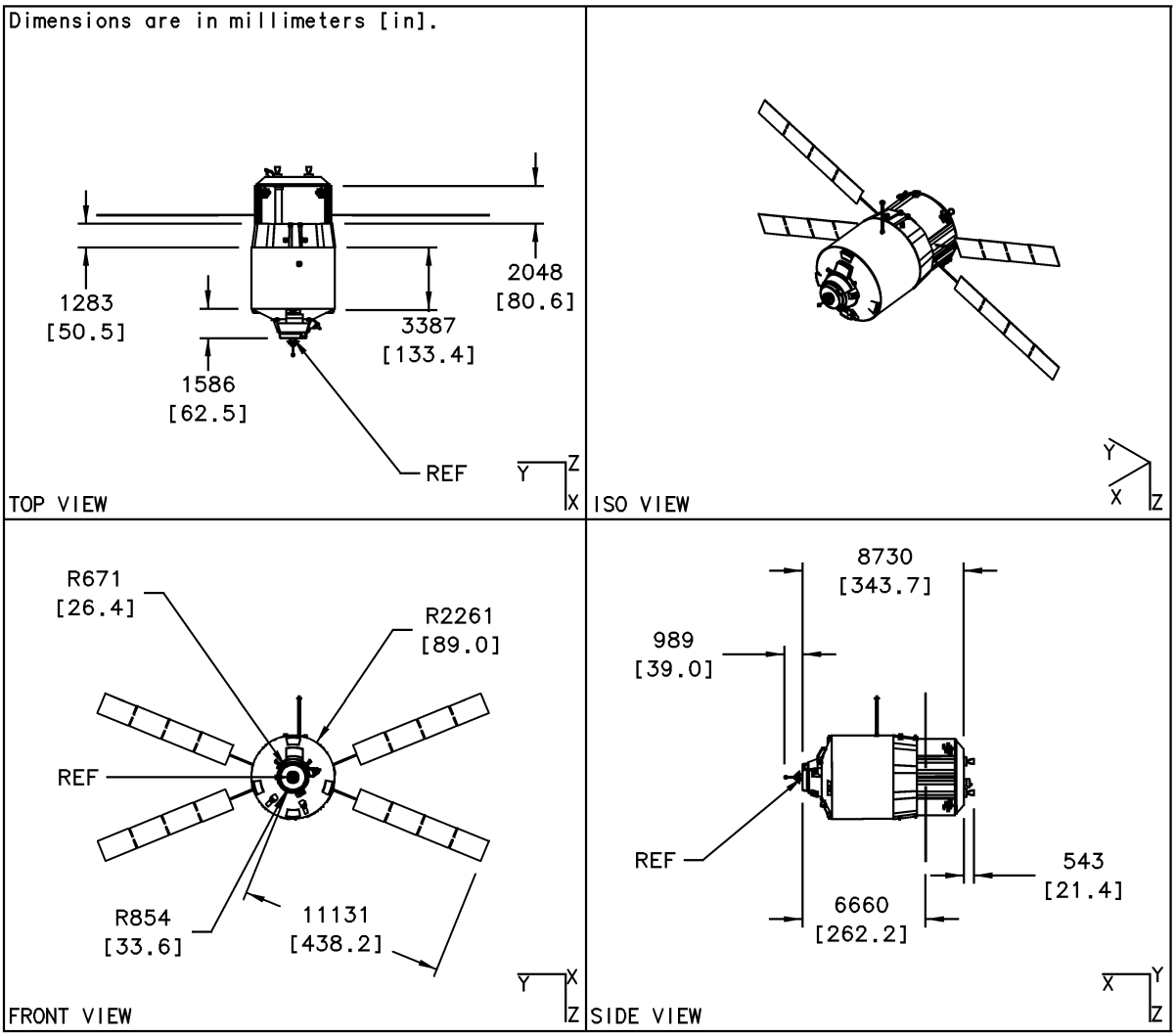
Stage 1E – After Separation

Element Properties:

Automated Trasfer Vehicle (ATV)

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
20150	X =	-40889	X =	-35691	352	55878	251	275
	Y =	-4	Y =	-6	0	251	132218	-201
	Z =	4097	Z =	4142	0	275	-201	135412

Reference Point Description: Center of forward docking interface plane



STEP 002

Stage 1E – After Separation

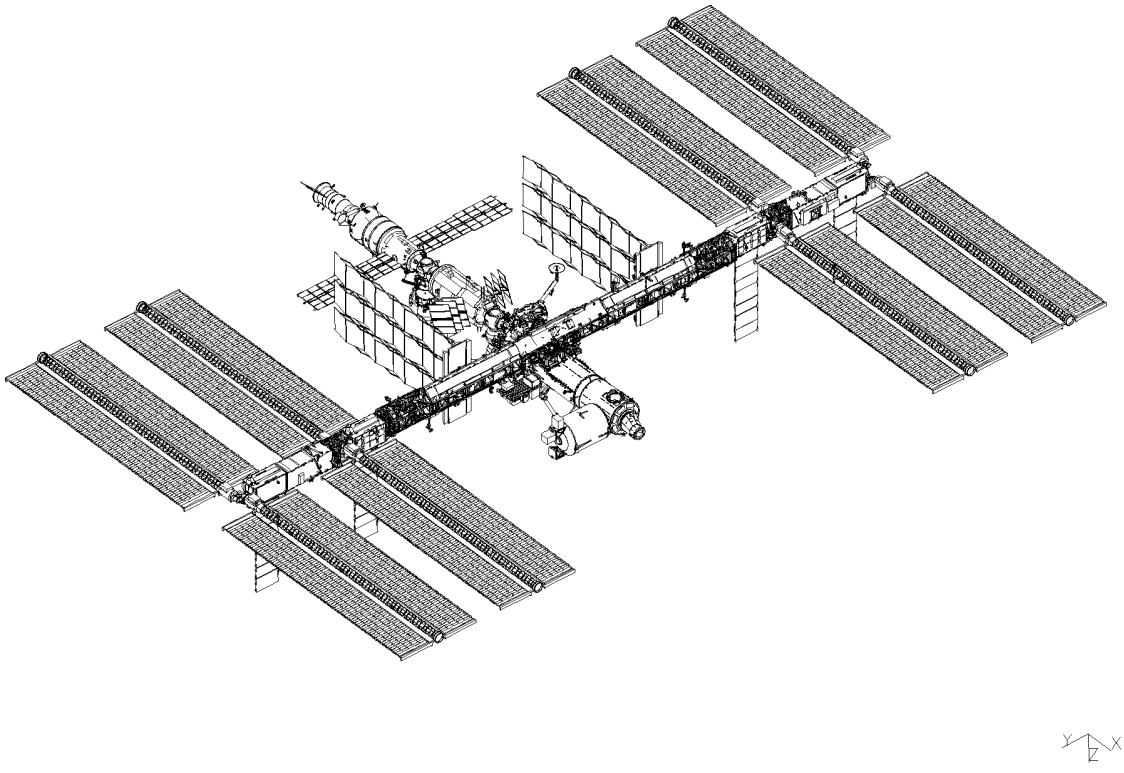
Element Properties:

Density Lab Module 1E Stage

Mass	Center of Mass		Reference Point			Inertia Tensor		
[kg]	[mm]			ISS [mm]	RSA [mm]	[kg*m^2]		
24234	X =	2006	X =	6302	-41641	2436	-2367	-129
	Y =	-36	Y =	7	-712	-2367	3057	-102
	Z =	4830	Z =	4854	-13	-129	-102	4833

Reference Point Description: Center of forward CBM interface plane

Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 002		
M. Falou/LM/281-333-6326	Stage 1E ISS - After Separation		
Produced By	Contract		Item Number
Theresa Tran	NAS9-19100 Science Engineering Analysis & Test		03-DR0008
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/30/03



Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 002		
M. Falou/LM/281-333-6326	Stage 1E ISS - After Separation		
Produced By	Contract		Item Number
Theresa Tran	NAS9-19100 Science Engineering Analysis & Test		03-MP0033
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/13/03

```
Total mass:             592237. lb
                        268634. kg

Center of mass:
                           X           Y           Z
                        -18.69        1.44       10.42 ft
                         -5.70         .44        3.18 m

Inertia tensor*:
                                    slug*ft**2
                      72816720.   -1488081.    2333402.
                      -1488081.   37021988.    -330352.
                       2333402.    -330352.  105513176.

                                     kg*m**2
                      98726168.   -2017566.    3163667.
                      -2017566.   50195052.    -447897.
                       3163667.    -447897.  143056592.

Principal moments of inertia (IXX, IYY, IZZ):
                      72708589.   36958292.  105678356. slug*ft**2
                      98582624.   50110248.  143284992. kg*m**2

Principal to body roll, pitch, yaw in a 1 2 3 sequence:
                          -.20       -4.09        2.35 degrees

Center of pressure:
(WRT CM)                   X ft        Y ft        Z ft
                  CPx   .00E+00   -9.09E-01    5.22E-02
                  CPy -1.86E+01     .00E+00   -1.49E+00
                  CPz  1.30E+01   -1.85E+00     .00E+00

                           X m         Y m         Z m
                  CPx   .00E+00   -2.77E-01    1.59E-02
                  CPy -5.67E+00     .00E+00   -4.53E-01
                  CPz  3.97E+00   -5.63E-01     .00E+00

Projected areas:
                           X           Y           Z
                        7575.47     5087.38    32370.64 ft**2
                         703.78      472.63     3007.33 m**2

*Off-diagonal elements are negative integrals
```

STEP 003

Stage 1J – After Separation

- On Stage UF-4, the Special Purpose Dexterious Manipulator (SPDM) was intalled on the MBS-PDGF1. MT/CETA starboard rails were attached to the truss segments ITS S4, ITS S5, ITS S6
- On Stage UF-4.1, the upper inboard PAS of the ITS S3 UCLA was deployed for the AMS. The Alpha Magnetic Spectrometer (AMS) was installed on the ITS S3 upper inboard PAS.
- On Stage 1J/A, the Experiment Logistics Module Pressurized Section (ELM PS) was delivered and installed on the Node 2 port CBM.
- On Stage 1J, Japanese Experiment Module Pressurized Module (JEM PM) installed on Node 2 port CBM

STEP 003

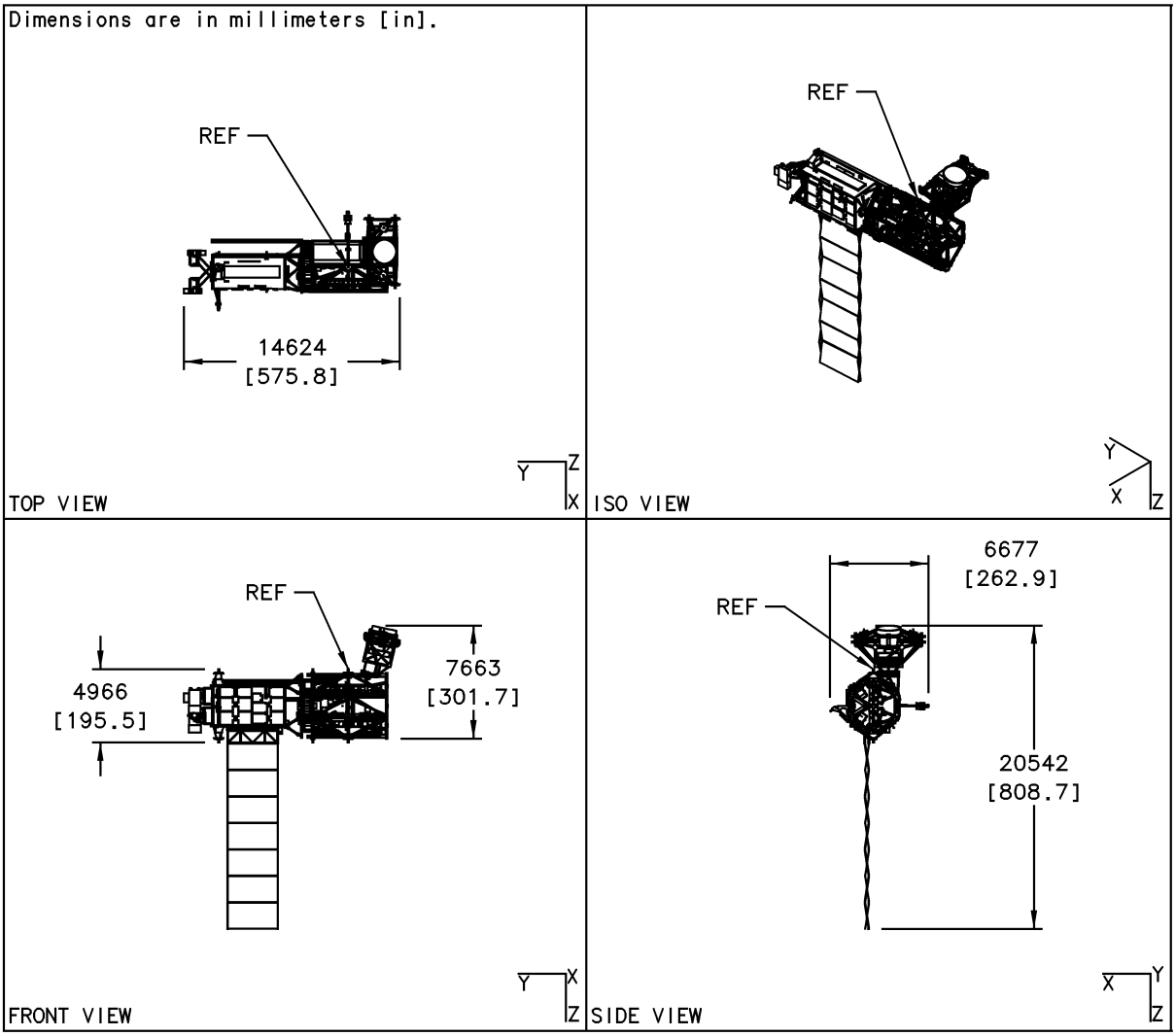
Stage 1J – After Separation

Element Properties:

S3/S4 Truss Assembly (Alpha Magnetic Spectrometer (AMS) and CETA rail installed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
21037	X =	-118	X =	0	-35339	477636	-42400	-16633
	Y =	26136	Y =	22994	6625	-42400	131786	-128553
	Z =	-1047	Z =	-2483	-23000	-16633	-128553	379677

Reference Point Description: Center of S3 port zenith trunnion pin



STEP 003

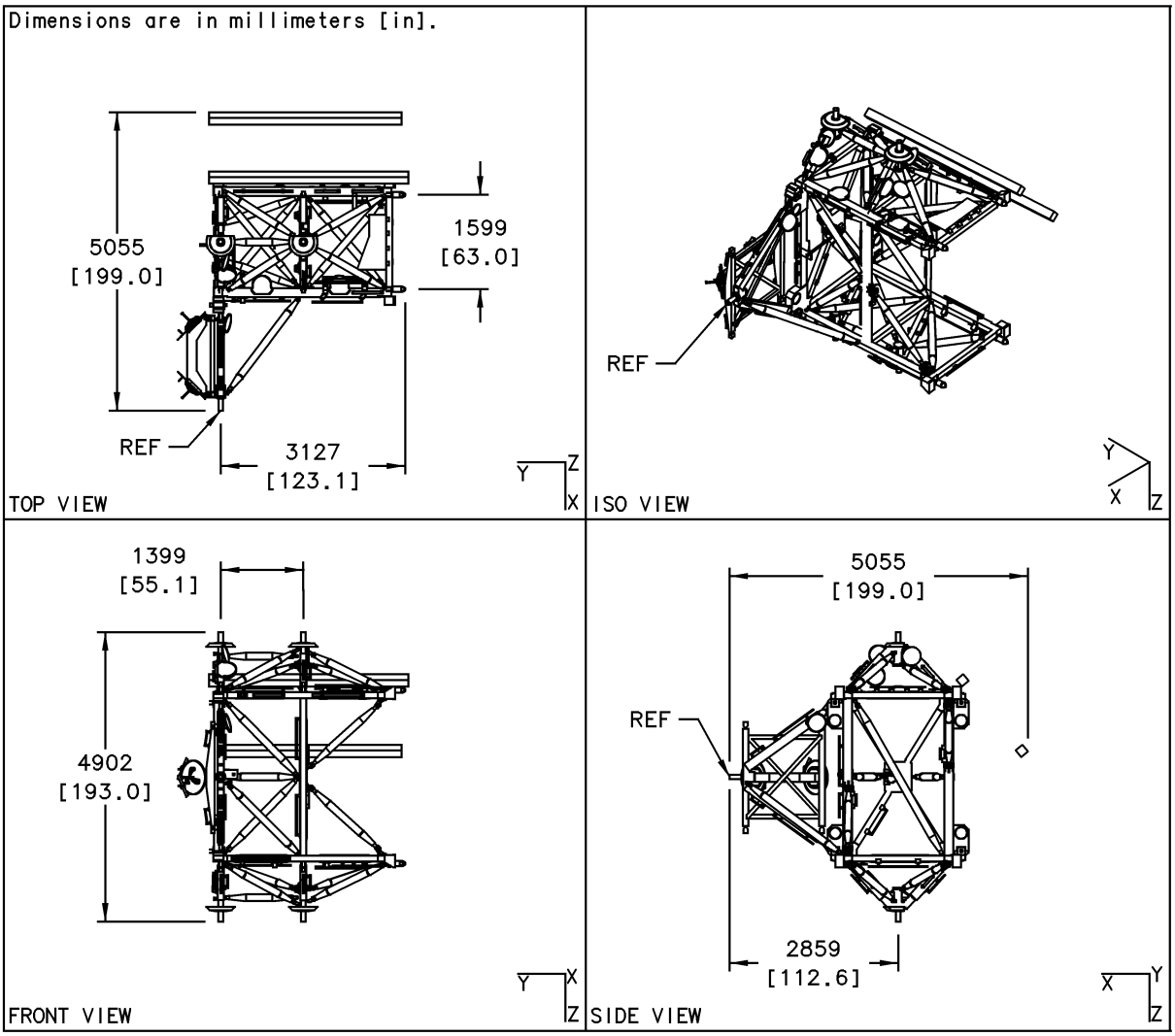
Stage 1J – After Separation

Element Properties:

S5 Truss Assembly (CETA rail installed)

Mass	Center of Mass		Reference Point			Inertia Tensor		
[kg]	[mm]			ISS [mm]	RSA [mm]	[kg*m^2]		
2167	X =	361	X =	3215	-38554	6146	-653	-312
	Y =	34322	Y =	35318	4142	-653	6102	-469
	Z =	-173	Z =	0	-35324	-312	-469	4557

Reference Point Description: Center of keel pin



STEP 003

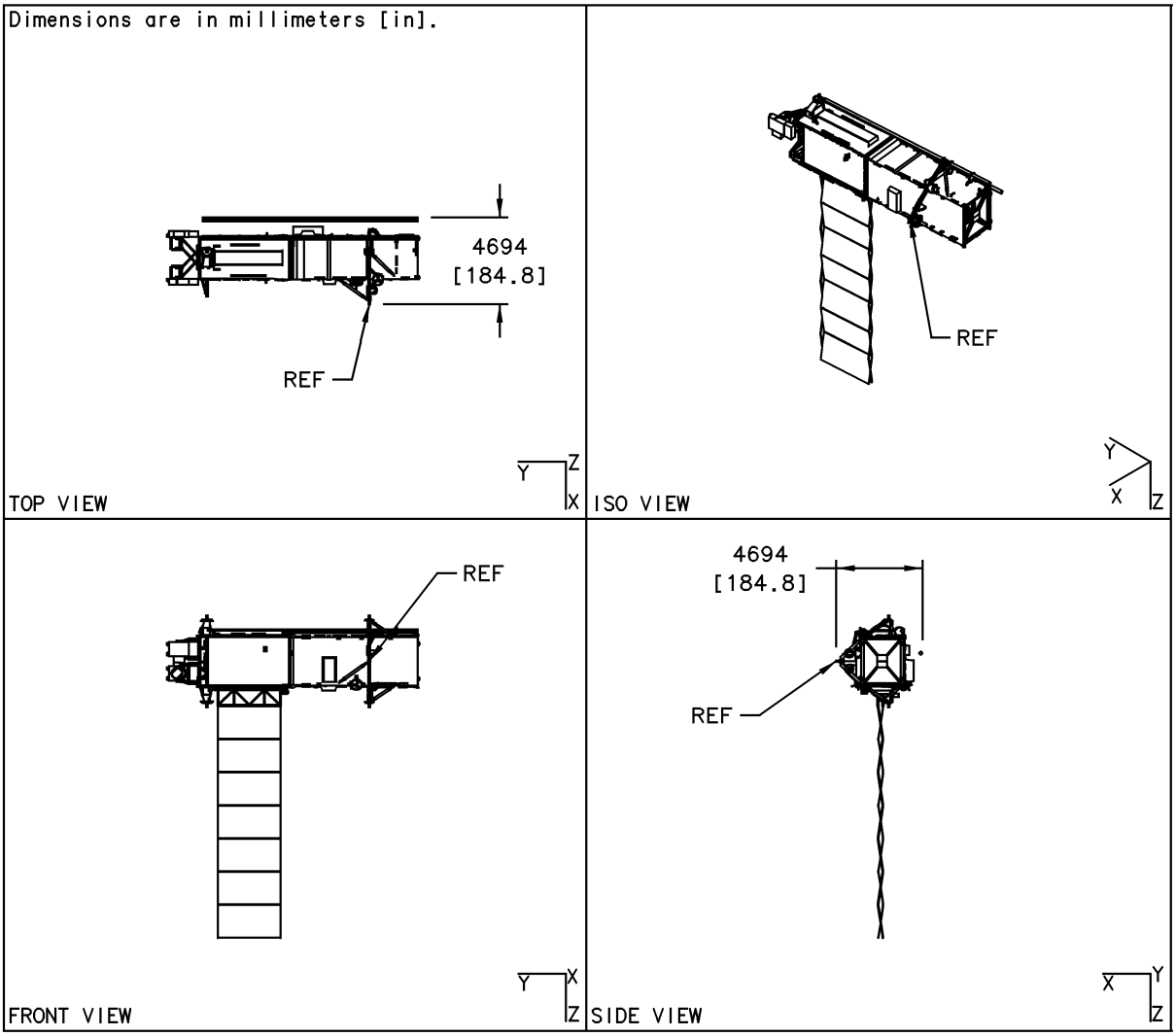
Stage 1J – After Separation

Element Properties:

S6 Truss Assemby (CETA rail installed)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
12690	X =	213	X =	2855	-38194	170750	-7688	-3307
	Y =	43874	Y =	38143	4142	-7688	49126	-7319
	Z =	194	Z =	0	-38149	-3307	-7319	142976

Reference Point Description: Center of forward keel pin



STEP 003

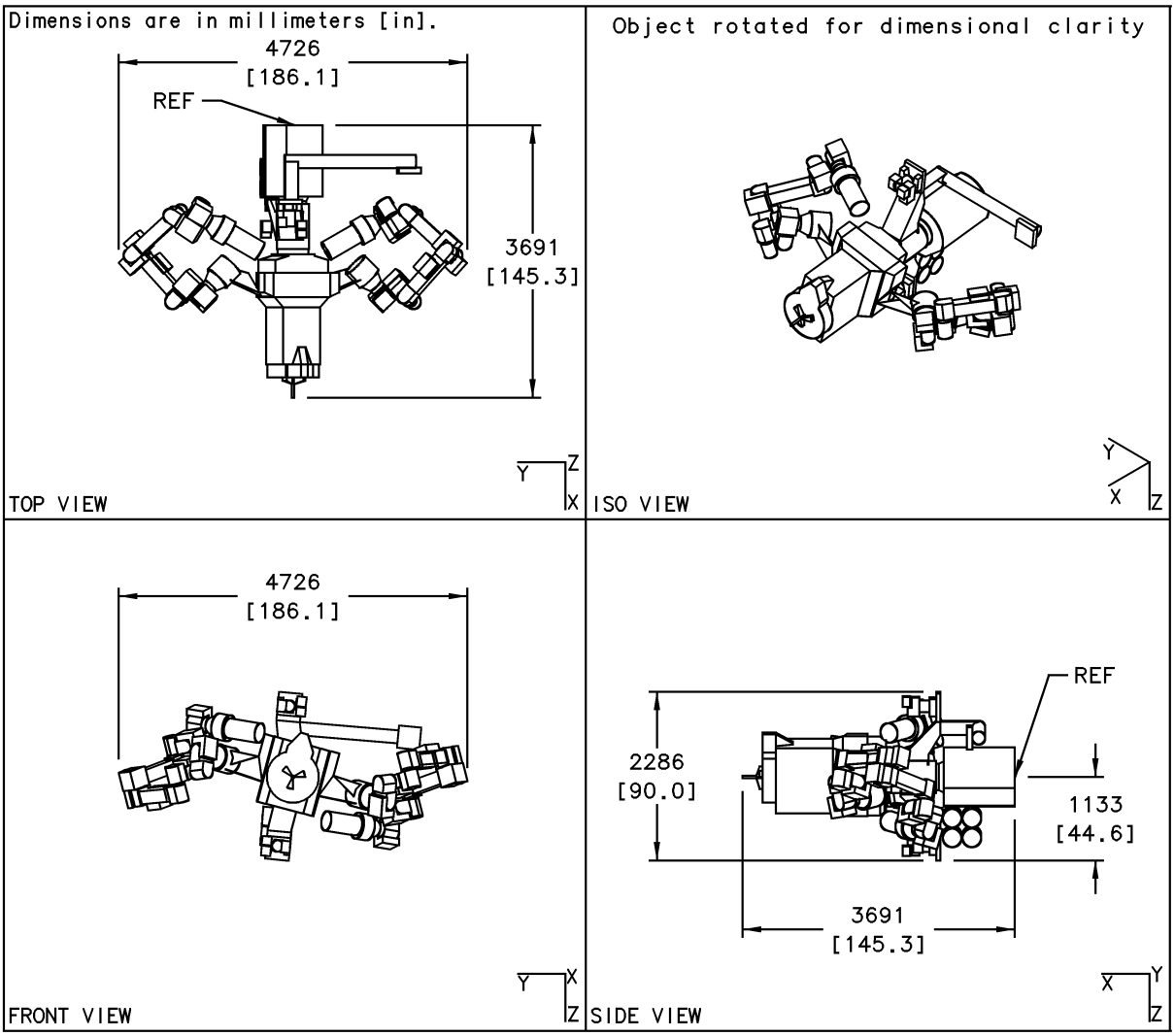
Stage 1J – After Separation

Element Properties:

SPDM on MBS PDGF 1

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1628	X =	4920	X =	3578	-38917	1373	-127	-271
	Y =	5167	Y =	4241	3184	-127	1365	-44
	Z =	1409	Z =	958	-4247	-271	-44	2156

Reference Point Description: Center of interface plane with MBS PDGF



STEP 003

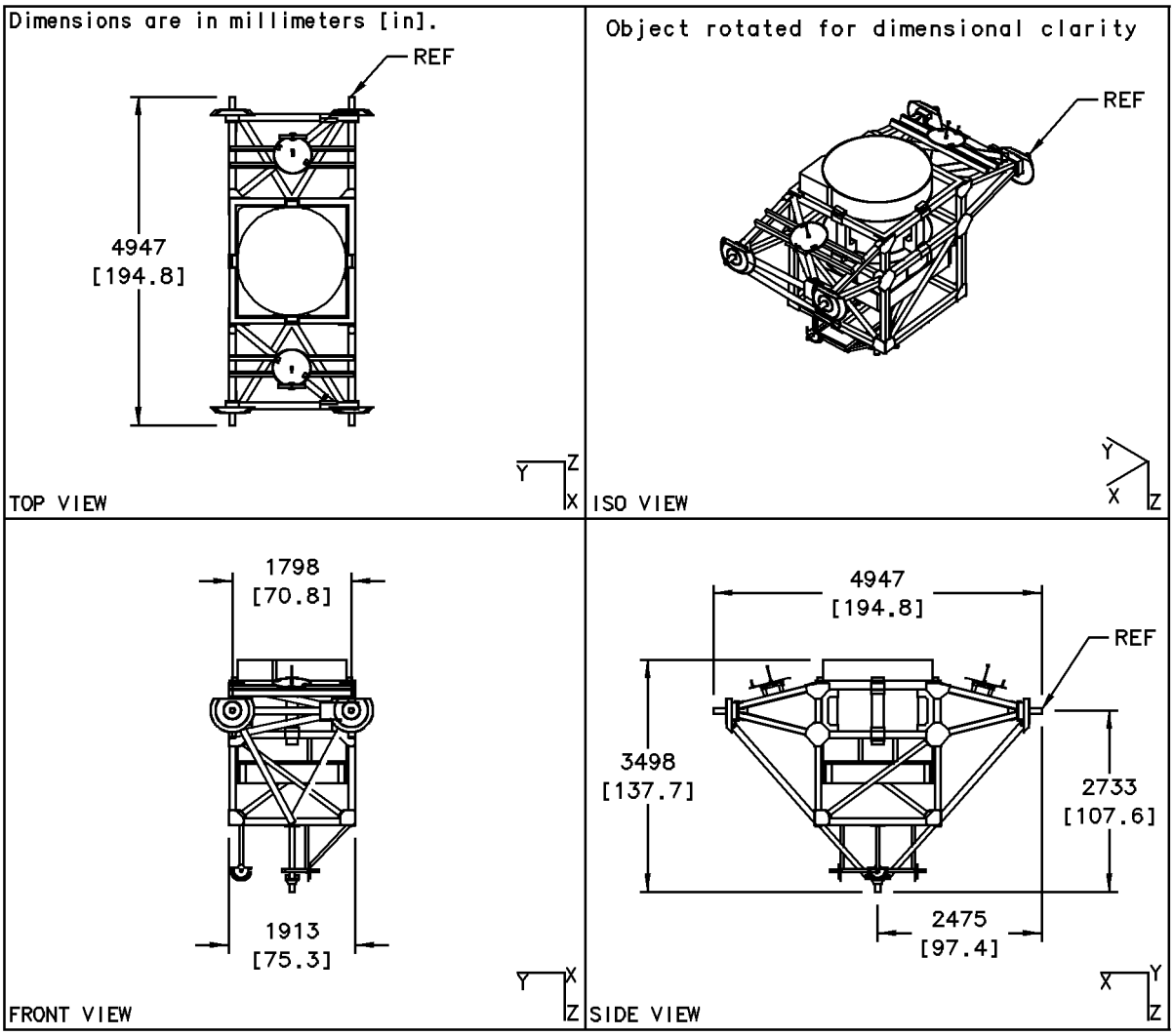
Stage 1J – After Separation

Element Properties:

AMS on S3 upper inboard Payload Attach Site (PAS)

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
6717	X =	-922	X =	1457	-36796	963	8	-1
	Y =	21404	Y =	19828	8470	8	646	3
	Z =	-3713	Z =	-4328	-19834	-1	3	836

Reference Point Description: Center of aft, port trunnion pin



STEP 003

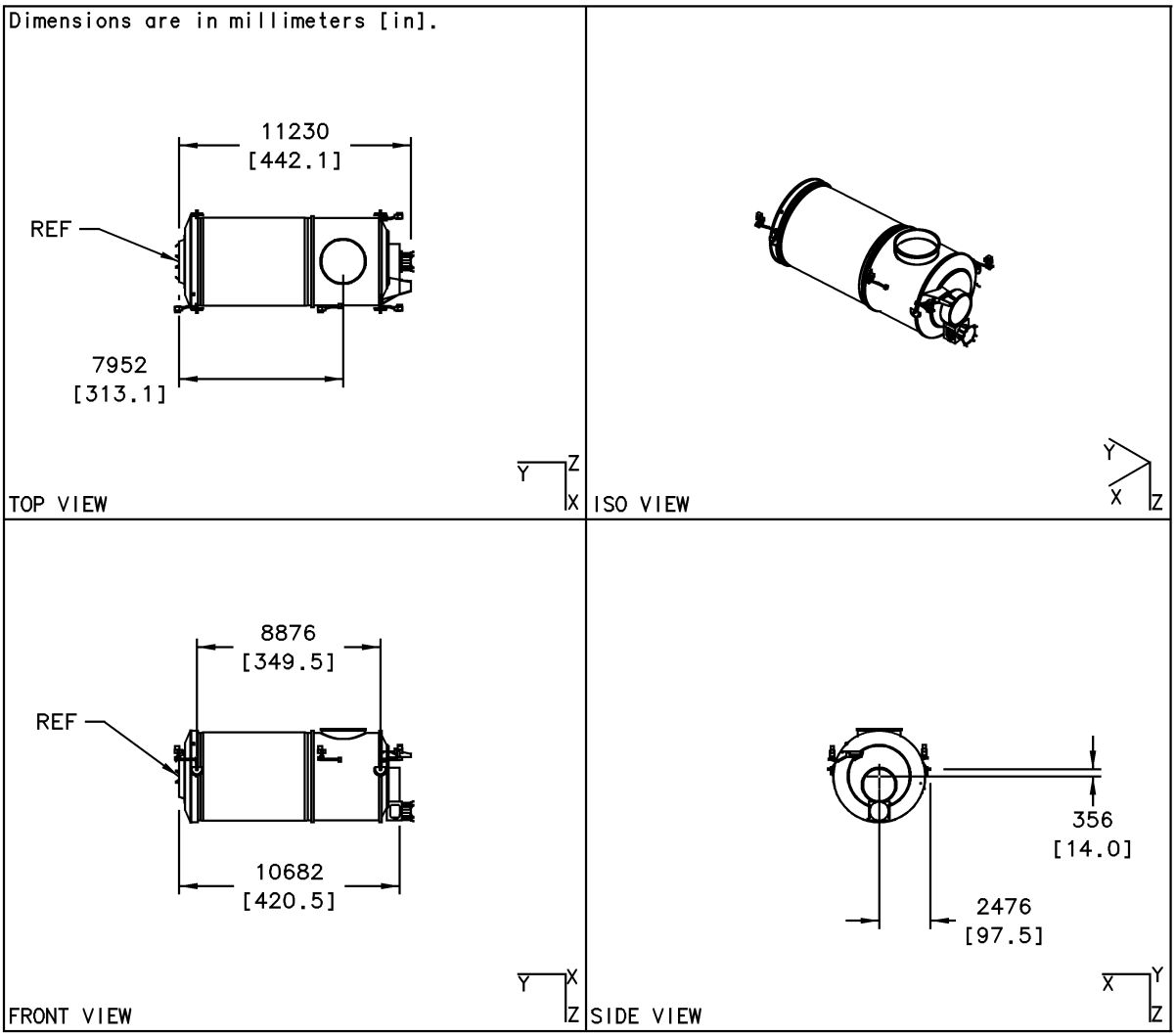
Stage 1J – After Separation

Element Properties:

NASDA Japanese Experiment Module (JEM) Pressurized Module (PM)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
20681	X =	10957	X =	10935	-46274	217989	92	-158
	Y =	-7345	Y =	-1992	-712	92	70794	-2234
	Z =	4987	Z =	4854	1986	-158	-2234	215667

Reference Point Description: Center of starboard docking interface plane



STEP 003

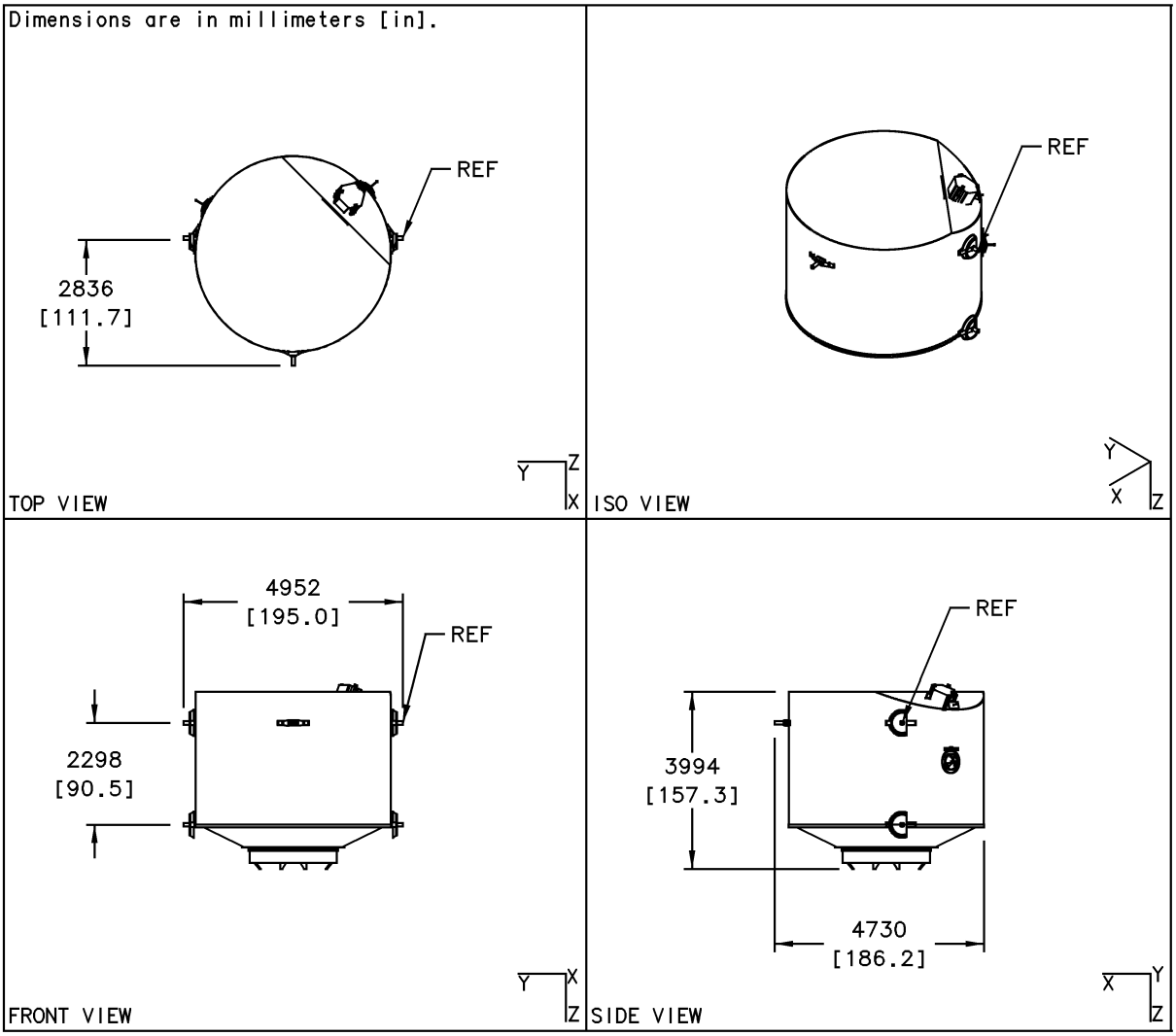
Stage 1J – After Separation

Element Properties:

NASDA JEM Experiment Logistics Module (ELM) Pressurized Section (PS)

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
4811	X =	11028	X =	10582	-45921	2972	-28	-237
	Y =	-9998	Y =	-12392	4459	-28	3919	-11
	Z =	949	Z =	-317	12386	-237	-11	3331

Reference Point Description: Center of port zenith trunnion pin



STEP 003

Stage 1J – After Separation

Element Properties:

Density Lab 1J Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
25649	X =	2014	X =	6302	-41641	70739	-3097	-4902
	Y =	-23	Y =	7	-712	-3097	166720	588
	Z =	4830	Z =	4854	-13	-4902	588	175731

Reference Point Description: Center of forward CBM interface plane

P1 Truss Segment 1J Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
7190	X =	577	X =	0	-35339	153197	7504	-212
	Y =	-12506	Y =	-17760	6625	7504	16303	1051
	Z =	-9	Z =	-2483	17754	-212	1051	144943

Reference Point Description: Center of port zenith trunnion pin

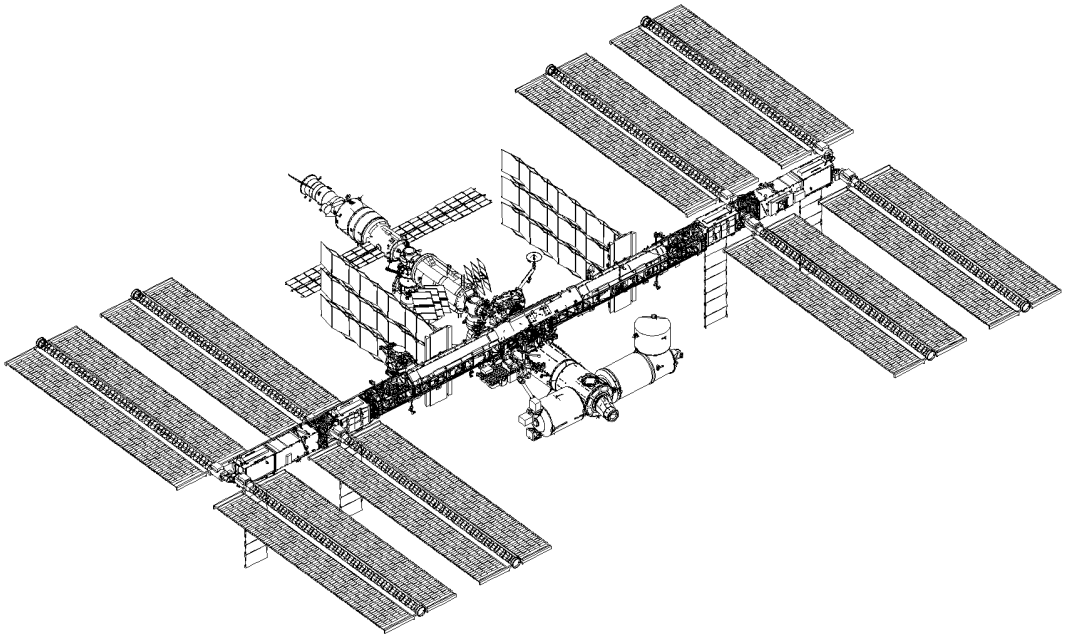
Node 2 1J Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
14107	X =	9889	X =	13038	-48377	32801	-574	-406
	Y =	-15	Y =	8	-719	-574	62203	-266
	Z =	4873	Z =	4861	-14	-406	-266	62035

Reference Point Description: Center of forward GBM interface plane

This page included for formatting purposes.

Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 003		
M. Falou/LM/281-333-6326	Stage 1J ISS – After Separation		
Produced By	Contract		Item Number
Dean Coleman	NAS9-19100 Science Engineering Analysis & Test		03-DR0009
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/30/03



Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 003		
M. Falou/LM/281-333-6326	Stage 1J ISS – After Separation		
Produced By	Contract		Item Number
Jeff Froemming	NAS9-19100 Science Engineering Analysis & Test		03-MP0034
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/13/03

Total mass: 671921. lb
304778. kg

Center of mass:

X	Y	Z	
-13.50	1.32	10.12	ft
-4.12	.40	3.08	m

Inertia tensor*:

slug*ft**2

78292472.	391362.	2178883.
391362.	42444984.	710319.
2178883.	710319.	115626704.

kg*m**2

106150296.	530615.	2954167.
530615.	57547648.	963062.
2954167.	963062.	156768688.

Principal moments of inertia (IXX, IYY, IZZ):

78166506.	42432972.	115756852.	slug*ft**2
105982792.	57533144.	156950016.	kg*m**2

Principal to body roll, pitch, yaw in a 1 2 3 sequence:

.54	-3.34	-.56	degrees

Center of pressure:

(WRT CM)	X ft	Y ft	Z ft
CPx	.00E+00	-1.15E+00	4.05E-01
CPy	-2.13E+01	.00E+00	-1.48E+00
CPz	8.50E+00	-1.78E+00	.00E+00

	X m	Y m	Z m
CPx	.00E+00	-3.50E-01	1.23E-01
CPy	-6.49E+00	.00E+00	-4.50E-01
CPz	2.59E+00	-5.42E-01	.00E+00

Projected areas:

X	Y	Z	
8030.11	5288.94	33011.66	ft**2
746.02	491.36	3066.88	m**2

*Off-diagonal elements are negative integrals

STEP 004

Stage 17A – After Separation

- On Stage ULF3, JEM PM and JEM ELM-PS racks were delivered.
- On ULF3, payloads 3 and 4 are deployed on the Columbus module.
- On 9A.1, MTsM was delivered and installed on FGB assembly
- On 20A, Node 3 was installed on Node 1 nadir CBM. PMA 3 was moved to Node 3 nadir port.
- Soyuz docked to the MTsM nadir docking port.

STEP 004

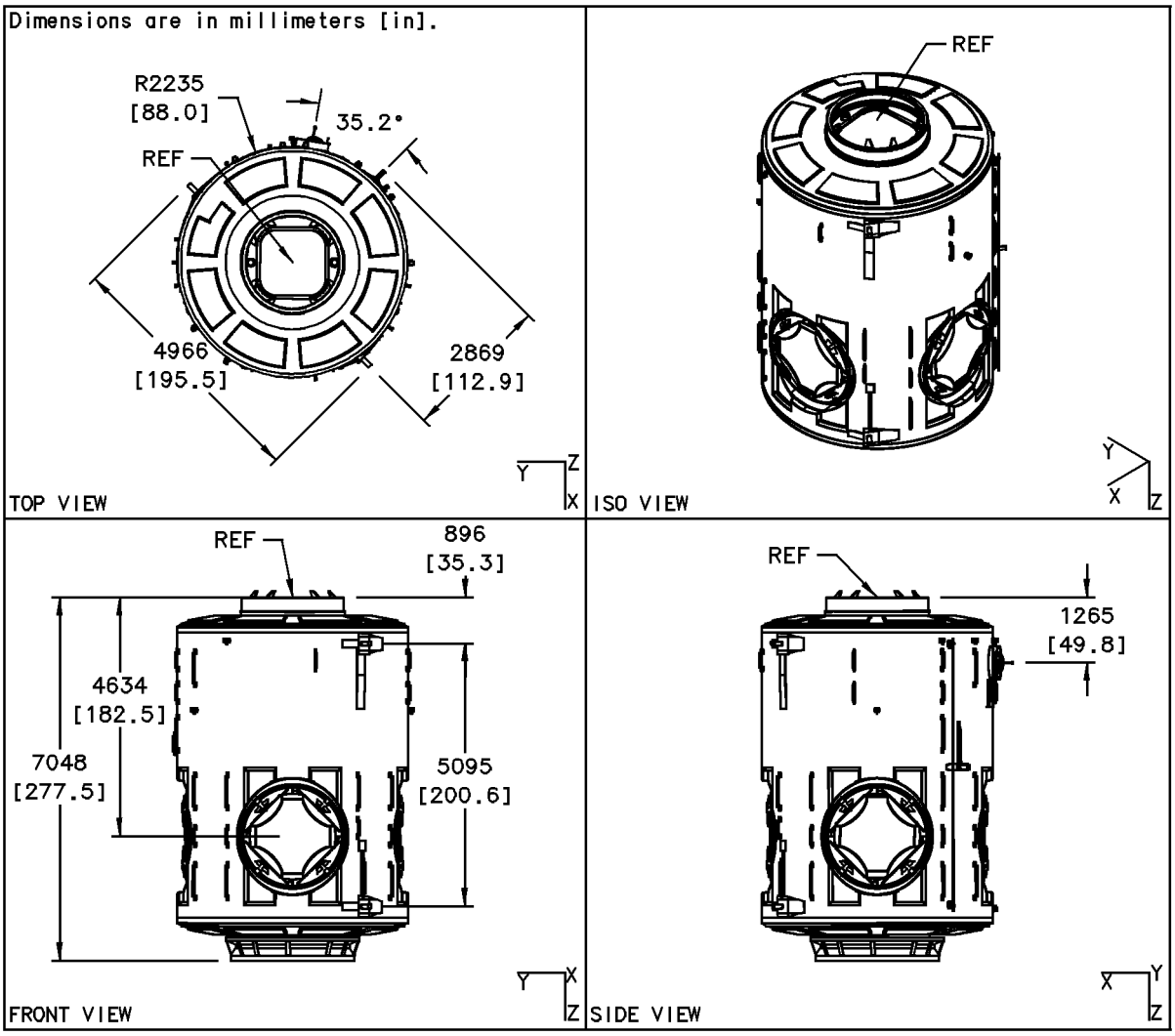
Stage 17A – After Separation

Element Properties:

Node 3

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
18833	X =	-4438	X =	-4463	-30876	85334	-203	-674
	Y =	58	Y =	-5	-2704	-203	87472	118
	Z =	10013	Z =	6846	-1	-674	118	55590

Reference Point Description: Center of zenith CBM interface plane



STEP 004

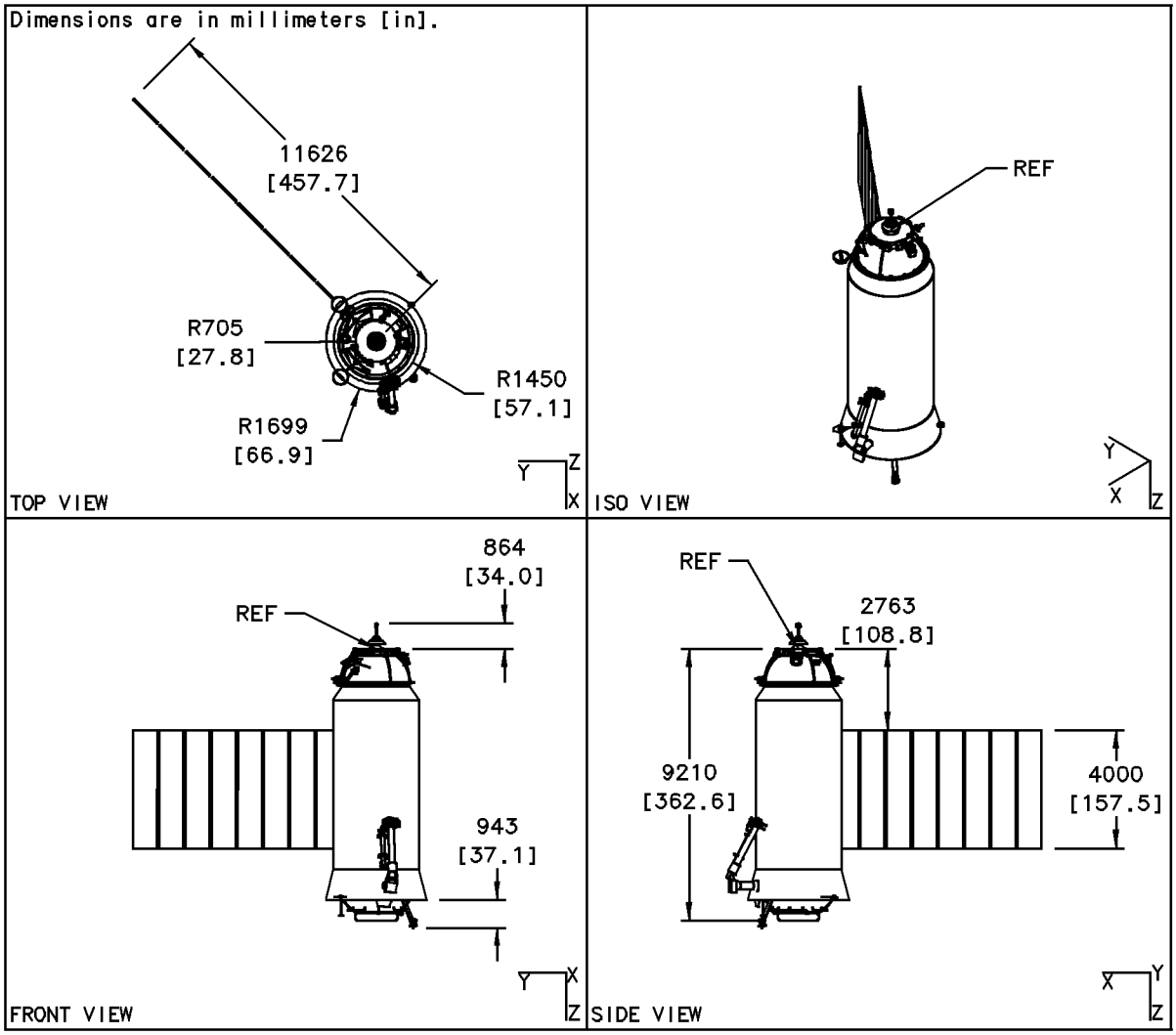
Stage 17A – After Separation

Element Properties:

RSA Multi Purpose Module (MTsM)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
17765	X =	-11136	X =	-11134	-24205	102892	14329	-54
	Y =	-4	Y =	-6	-1143	14329	105168	162
	Z =	9374	Z =	5285	0	-54	162	31234

Reference Point Description: Center of zenith interface plane



STEP 004

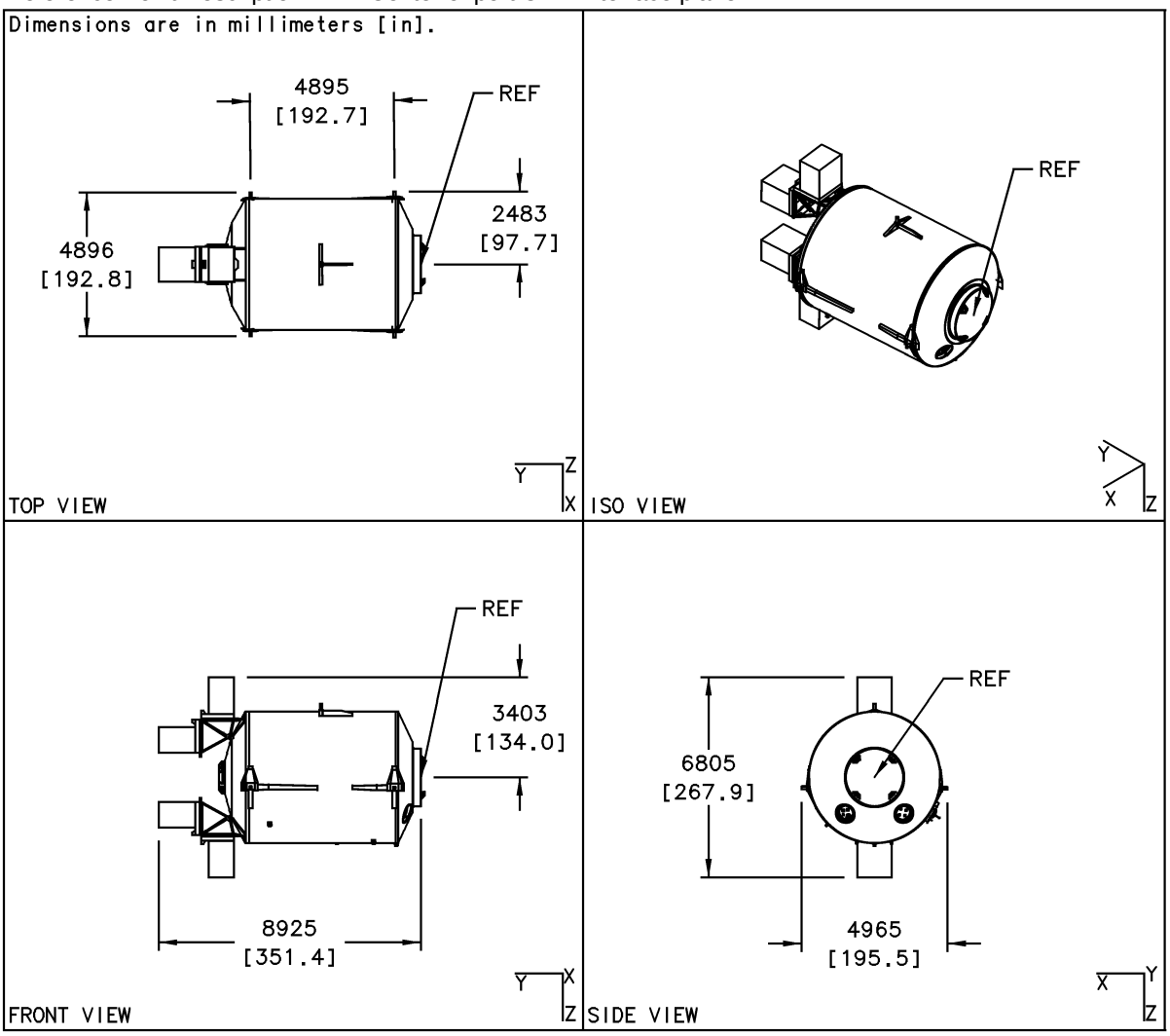
Stage 17A – After Separation

Element Properties:

ESA Columbus Module 17A Stage

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
16750	X =	10707	X =	10934	-46273	100389	1166	23
	Y =	5908	Y =	2007	-719	1166	50634	452
	Z =	4830	Z =	4861	-2013	23	452	94408

Reference Point Description: Center of port CBM interface plane



STEP 004

Stage 17A – After Separation

Element Properties:

Density Lab Module 17A Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
26316	X =	2072	X =	6302	-41641	70363	695	-4795
	Y =	-57	Y =	7	-712	695	167040	718
	Z =	4824	Z =	4854	-13	-4795	718	176333

Reference Point Description: Center of forward CBM interface plane

Node 2 17A Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
15062	X =	9765	X =	13038	-48377	35546	-562	249
	Y =	-14	Y =	8	-719	-562	67361	194
	Z =	4908	Z =	4861	-14	249	194	66501

Reference Point Description: Center of forward CBM interface plane

PMA3 at Node 3 nadir port

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
1168	X =	-4033	X =	-4470	-30869	1185	4	-220
	Y =	-24	Y =	-4	-9435	4	1245	23
	Z =	14709	Z =	13577	-2	-220	23	990

Reference Point Description: Center of Zenith CBM interface plane

NASDA JEM PM 17A Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
21229	X =	10956	X =	10935	-46274	219545	97	-176
	Y =	-7334	Y =	-1992	-712	97	72441	-1875
	Z =	4964	Z =	4854	1986	-176	-1875	216110

Reference Point Description: Center of starboard interface plane

STEP 004

Stage 17A – After Separation

Element Properties:

NASDA JEM ELM-PS 17A Stage

Mass	Center of Mass		Reference Point			Inertia Tensor		
[kg]	[mm]			ISS [mm]	RSA [mm]	[kg*m^2]		
	X =	11018	X =	10582	-45921	2977	-25	-219
4843	Y =	-9998	Y =	-12392	4459	-25	3996	-11
	Z =	951	Z =	-317	12386	-219	-11	3405

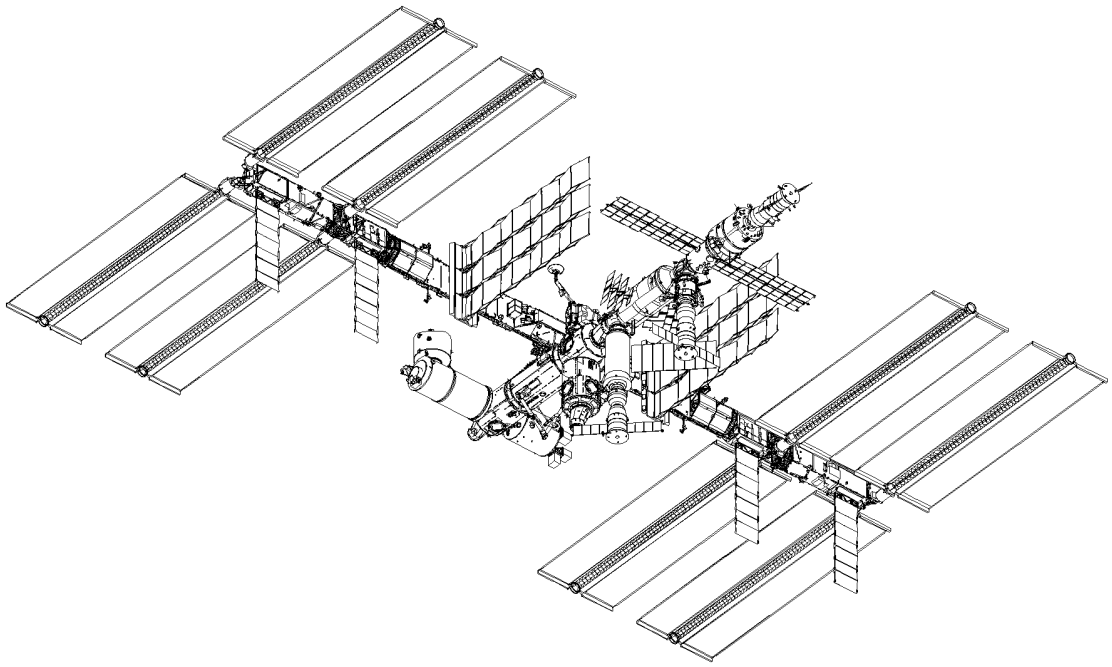
Reference Point Description: Center of port zenith trunnion pin

Soyuz at MTsM nadir

Mass	Center of Mass		Reference Point			Inertia Tensor		
[kg]	[mm]			ISS [mm]	RSA [mm]	[kg*m^2]		
	X =	-11158	X =	-11134	-24205	24101	456	4
6745	Y =	2	Y =	-6	-10353	456	24100	4
	Z =	18637	Z =	14495	0	4	4	4675

Reference Point Description: Center of zenith docking interface plane

Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 004		
M. Falou/LM/281-333-6326	Stage 17A ISS – After Separation		
Produced By	Contract		Item Number
Brad Henry	NAS9-19100 Science Engineering Analysis & Test		03-DR0010
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/30/03



Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 004		
M. Falou/LM/281-333-6326	Stage 17A ISS – After Separation		
Produced By	Contract		Item Number
Jeff Froemming	NAS9-19100 Science Engineering Analysis & Test		03-MP0035
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/13/03

```
Total mass:              759554. lb
                         344528. kg

Center of mass:
                            X           Y           Z
                         -14.40        1.18       13.16 ft
                          -4.39         .36        4.01 m

Inertia tensor*:
                                    slug*ft**2
                        80586664.     358106.    2985034.
                          358106.   45646336.     776955.
                         2985034.     776955.  116741952.

                                     kg*m**2
                       109260792.     485526.    4047160.
                          485526.   61888096.    1053410.
                         4047160.    1053410.  158280768.

Principal moments of inertia (IXX, IYY, IZZ):
                         80341640.   45633422.  116991883. slug*ft**2
                        108931968.   61872504.  158624544. kg*m**2

Principal to body roll, pitch, yaw in a 1 2 3 sequence:
                                .61       -4.70        -.49 degrees

Center of pressure:
(WRT CM)                      X ft        Y ft        Z ft
                     CPx   .00E+00   -4.51E-01   -6.70E-01
                     CPy -2.04E+01     .00E+00    3.33E-01
                     CPz  9.37E+00   -1.65E+00     .00E+00

                              X m         Y m         Z m
                     CPx   .00E+00   -1.38E-01   -2.04E-01
                     CPy -6.20E+00     .00E+00    1.02E-01
                     CPz  2.86E+00   -5.02E-01     .00E+00

Projected areas:
                            X           Y           Z
                         8508.69     6144.91    33033.75 ft**2
                          790.48      570.88     3068.94 m**2

*Off-diagonal elements are negative integrals
```

STEP 005

Stage 2 J/A – After Separation

- On UF-7, the CAM was installed on Node 2 zenith CBM.
- On 2J/A flight, the JEM Exposed Facility (EF) is delivered and installed on the port side of the JEM PM. The JEM Experiment Logistic Module Exposed Section (ELM-ES) is delivered and installed on the JEM EF.

STEP 005

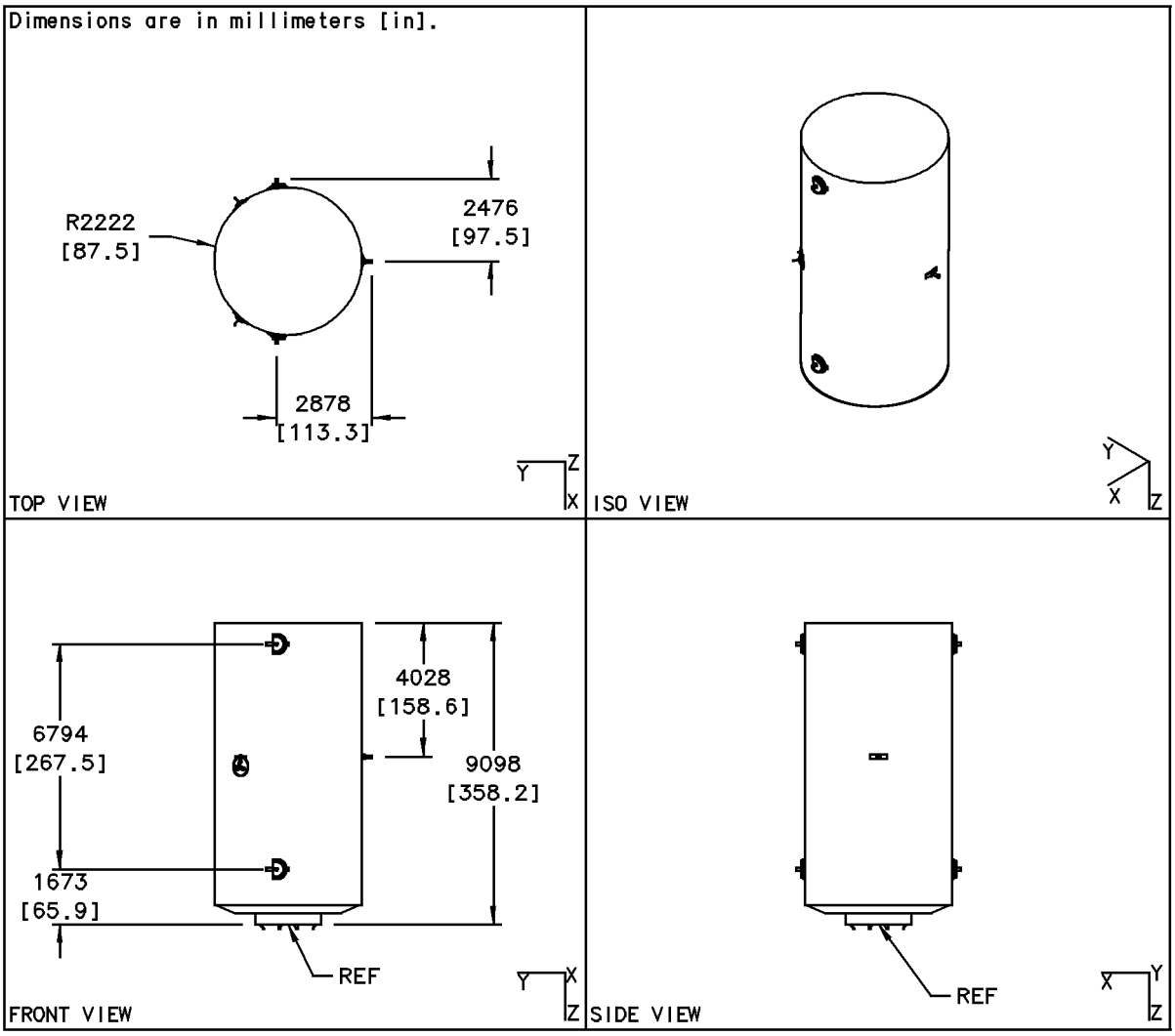
Stage 2 J/A – After Separation

Element Properties:

Centrifuge Accomodation Module (CAM)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
14042	X =	11032	X =	10937	-46276	322334	4	-1114
	Y =	17	Y =	11	1284	4	325475	-57
	Z =	-2152	Z =	2858	-17	-1114	-57	29467

Reference Point Description: Center of Nadir CBM interface plane



STEP 005

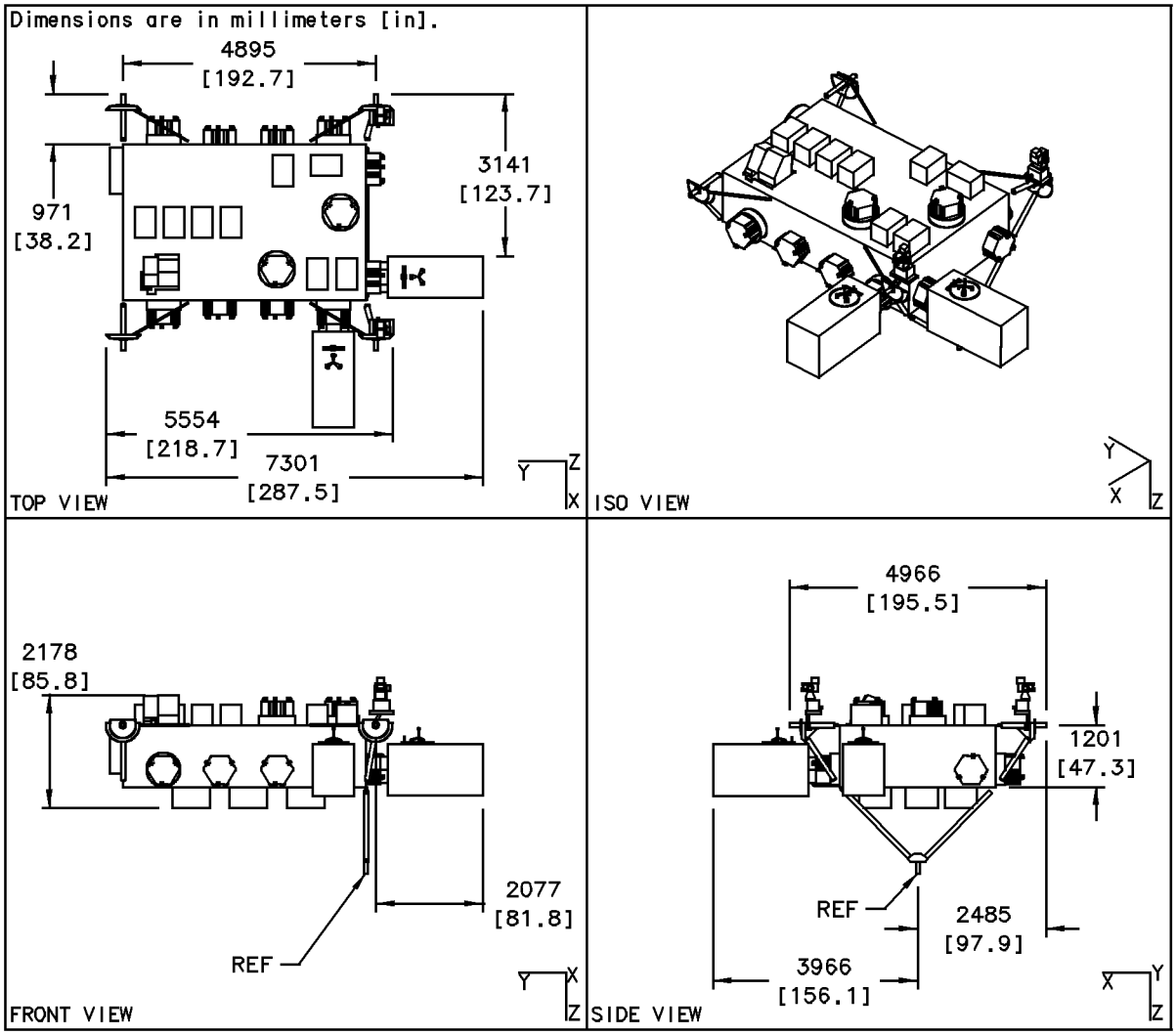
Stage 2 J/A – After Separation

Element Properties:

NASDA JEM Exposed Facility (EF)

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		RSA [mm]	Inertia Tensor [kg*m^2]		
4811	X =	12308	X =	11712	-47051	15864	0	0
	Y =	-16304	Y =	-18151	-4776	0	8525	0
	Z =	657	Z =	8918	18145	0	0	21155

Reference Point Description: Center of keel pin



STEP 005

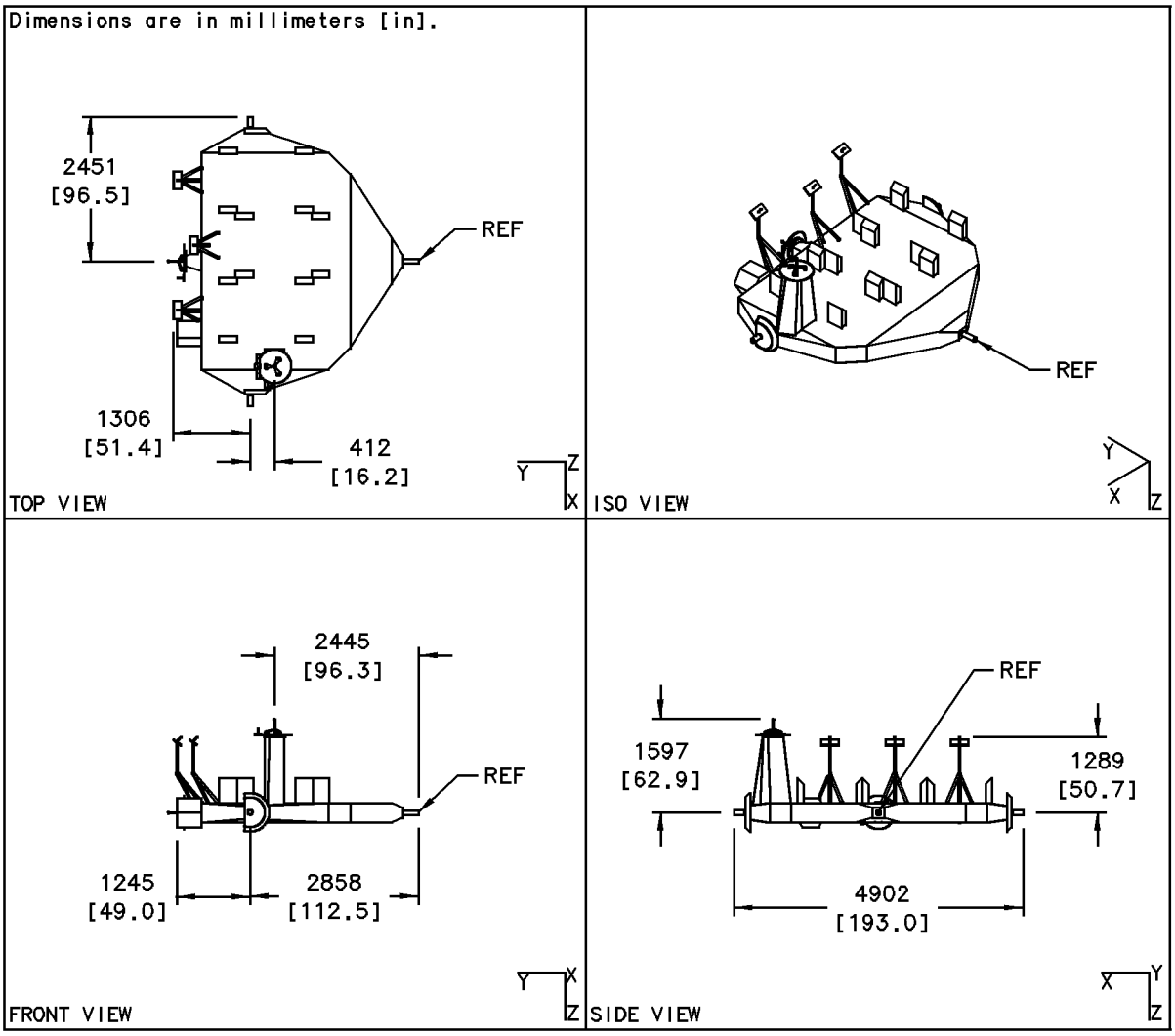
Stage 2 J/A – After Separation

Element Properties:

NASDA JEM Experiment Logistic Module Exposed Section (ELM-ES)

Mass [kg]	Center of Mass [mm]		Reference Point [mm]	ISS	RSA	Inertia Tensor [kg*m^2]		
1356	X =	9663	X =	9561	-44900	1170	0	0
	Y =	-19960	Y =	-22498	-2774	0	2873	0
	Z =	6684	Z =	6916	22492	0	0	2873

Reference Point Description: Center of keel pin



STEP 005

Stage 2 J/A – After Separation

Element Properties:

Density Lab Module 2JA Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
25276	X =	2101	X =	6302	-41641	69645	-1766	-2924
	Y =	-79	Y =	7	-712	-1766	165410	460
	Z =	4909	Z =	4854	-13	-2924	460	179543

Reference Point Description: Center of forward CBM interface plane

Node 2 at 2JA Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
15082	X =	9765	X =	13038	-48377	35546	-562	249
	Y =	-14	Y =	8	-719	-562	67361	194
	Z =	4908	Z =	4861	-14	249	194	66501

Reference Point Description: Center of forward CBM interface plane

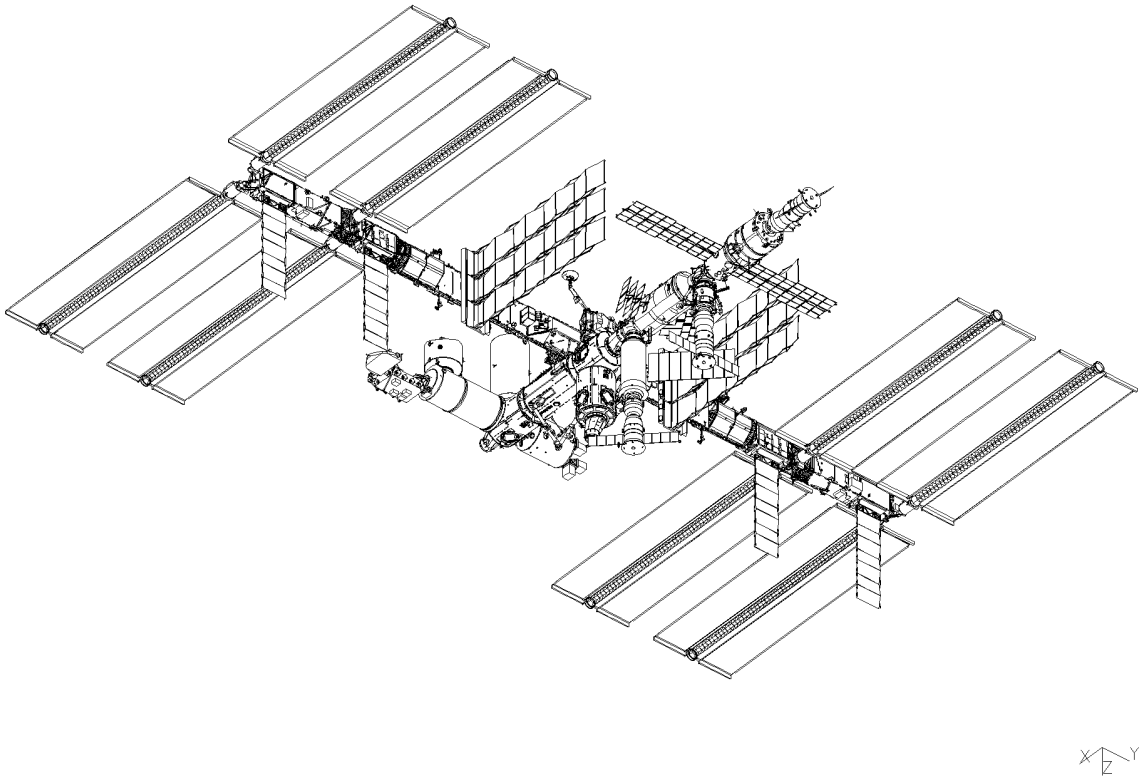
JEM PM 2JA Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
21280	X =	10956	X =	10935	-46274	219545	97	-176
	Y =	-7334	Y =	-1992	-712	97	72441	1875
	Z =	4964	Z =	4854	1986	-176	1875	216110

Reference Point Description: Center of starboard CBM interface plane

This page included for formatting purposes.

Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 005		
M. Falou/LM/281-333-6326	Stage 2J/A ISS – After Separation		
Produced By	Contract		Item Number
Dean Coleman	NAS9-19100 Science Engineering Analysis & Test		03-DR0011
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/30/03



Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 005		
M. Falou/LM/281-333-6326	Stage 2J/A ISS – After Separation		
Produced By	Contract		Item Number
Jeff Froemming	NAS9-19100 Science Engineering Analysis & Test		03-MP0036
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/13/03

```
Total mass:              801398. lb
                         363508. kg

Center of mass:
                            X           Y           Z
                         -11.60         .17       12.53 ft
                          -3.54         .05        3.82 m

Inertia tensor*:
                                     slug*ft**2
                        82626584.    1617921.    3731016.
                         1617921.   49745768.     977099.
                         3731016.     977099.  121595152.

                                      kg*m**2
                       112026552.    2193605.    5058576.
                         2193605.   67446176.    1324767.
                         5058576.    1324767.  164860816.

Principal moments of inertia (IXX, IYY, IZZ):
                        82340455.   49656046.  121962628. slug*ft**2
                       111642080.   67326616.  165364176. kg*m**2

Principal to body roll, pitch, yaw in a 1 2 3 sequence:
                               .64       -5.49       -2.68 degrees

Center of pressure:
(WRT CM)                      X ft        Y ft        Z ft
                     CPx   .00E+00   -3.47E-01   -5.33E-01
                     CPy -2.03E+01     .00E+00    4.92E-02
                     CPz  6.97E+00   -1.19E+00     .00E+00

                              X m         Y m         Z m
                     CPx   .00E+00   -1.06E-01   -1.62E-01
                     CPy -6.18E+00     .00E+00    1.50E-02
                     CPz  2.13E+00   -3.63E-01     .00E+00

Projected areas:
                            X           Y           Z
                         8815.68     6390.54    33359.87 ft**2
                          819.00      593.70     3099.23 m**2

*Off-diagonal elements are negative integrals
```

STEP 006

Stage 14A – Before Separation

- A Soyuz docked to the DC1 nadir docking port.
- On Stage 14A, the cupola was installed on Node 1 port CBM.
- On Stage 14A, the ITS S3 express pallet was installed on the ITS S3 outboard upper PAS.
- Prior to this stage, the Human Transfer Vehicle (HTV) visited the ISS and was berthed with the SSRMS to Node 2 nadir CBM port and then departed.

STEP 006

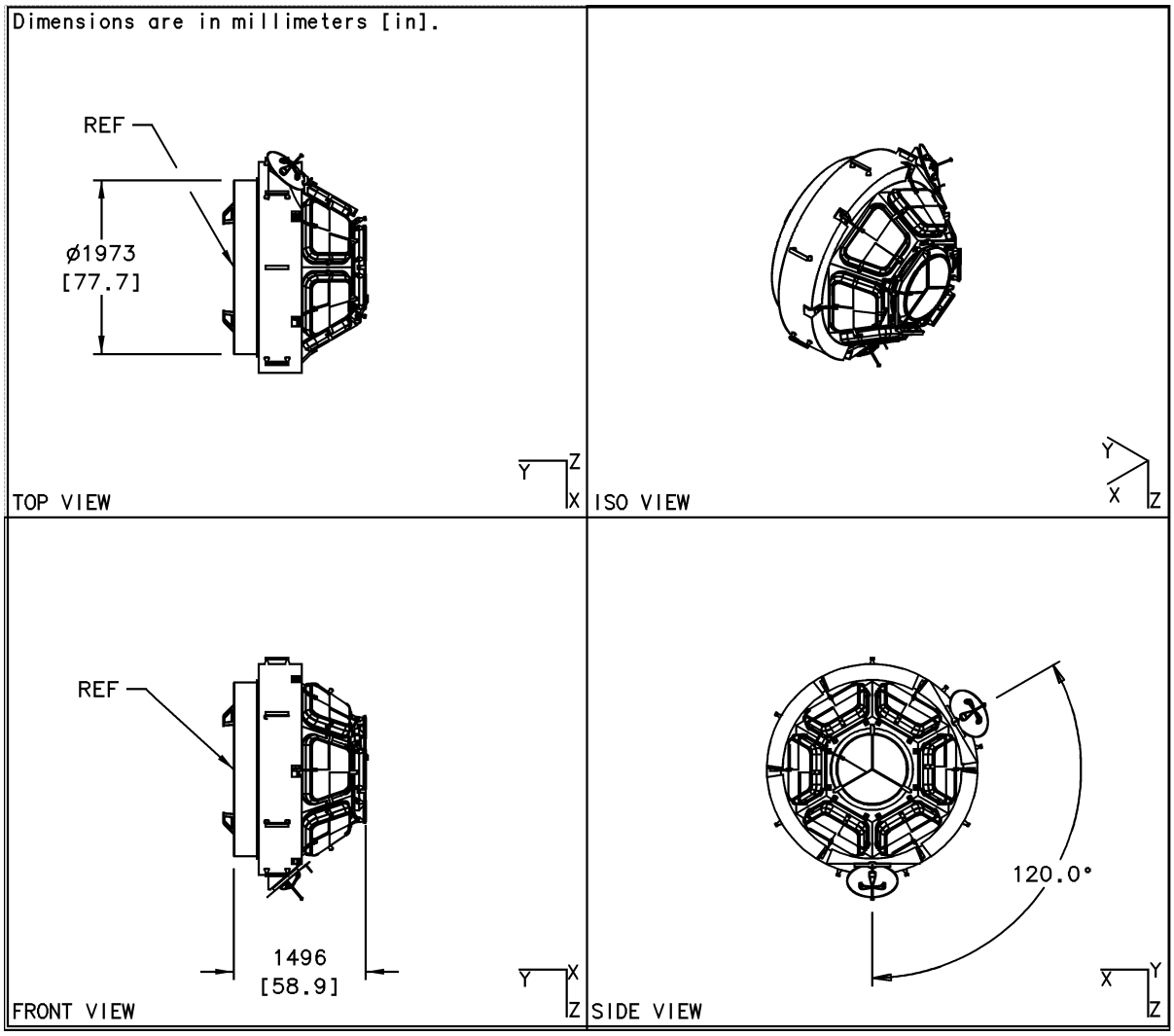
Stage 14A – Before Separation

Element Properties:

Cupola at Node 1 port CBM

Mass [kg]	Center of Mass [mm]		Reference Point ISS [mm]		Inertia Tensor [kg*m^2]		
1741	X =	-4463	X = -4463	-30876	522	0	0
	Y =	-2861	Y = -1997	-707	0	724	0
	Z =	4847	Z = 4849	1991	0	0	525

Reference Point Description: Center of starboard CBM interface plane



STEP 006

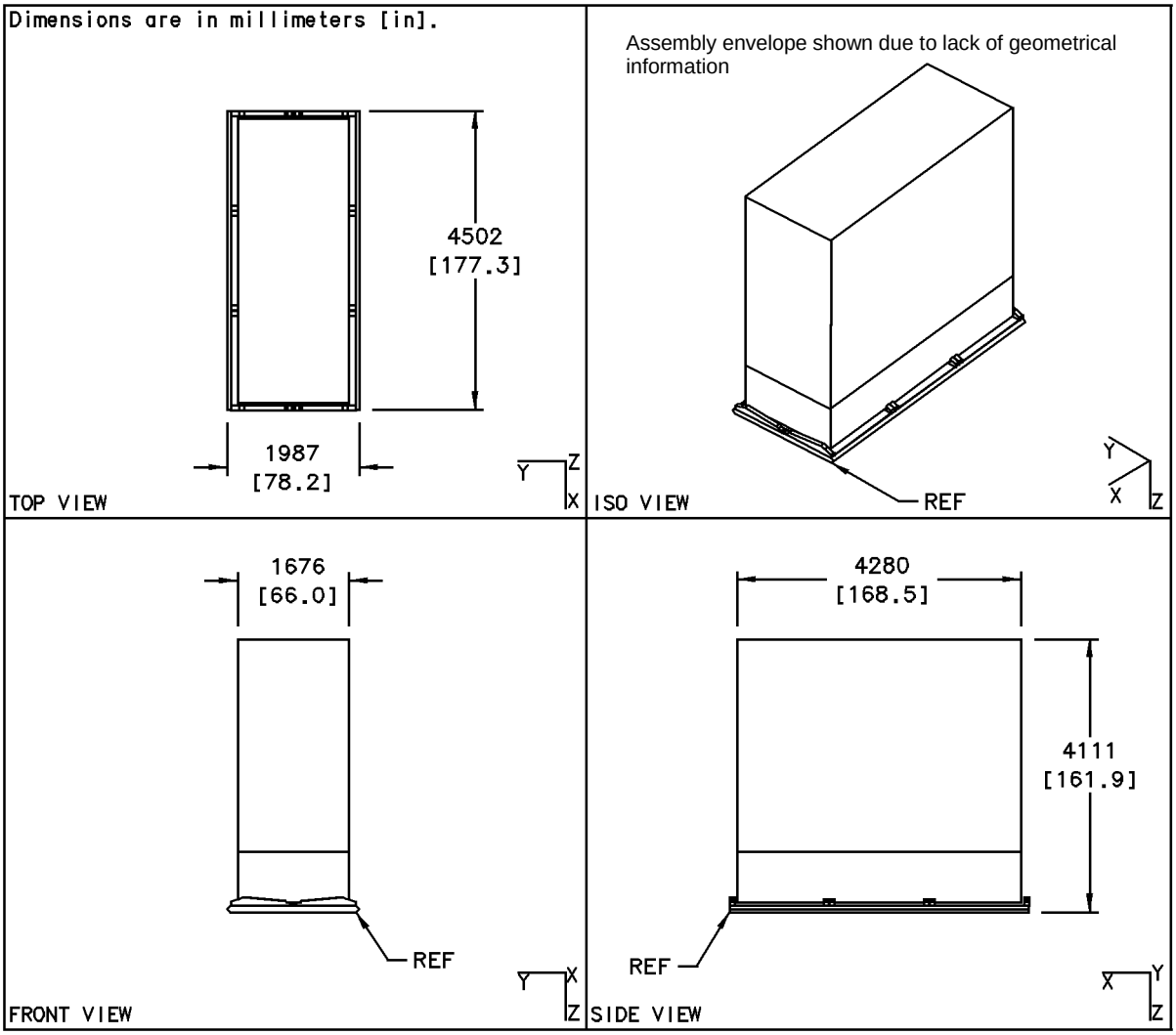
Stage 14A – Before Separation

Element Properties:

Express Pallet 1 on S3 outboard Upper PAS

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
3069	X =	-856	X =	1232	-36571	2588	0	0
	Y =	24749	Y =	23179	6238	0	6212	0
	Z =	-4583	Z =	-2096	-23185	0	0	5029

Reference Point Description: Fwd-stbd-nadir corner



STEP 006

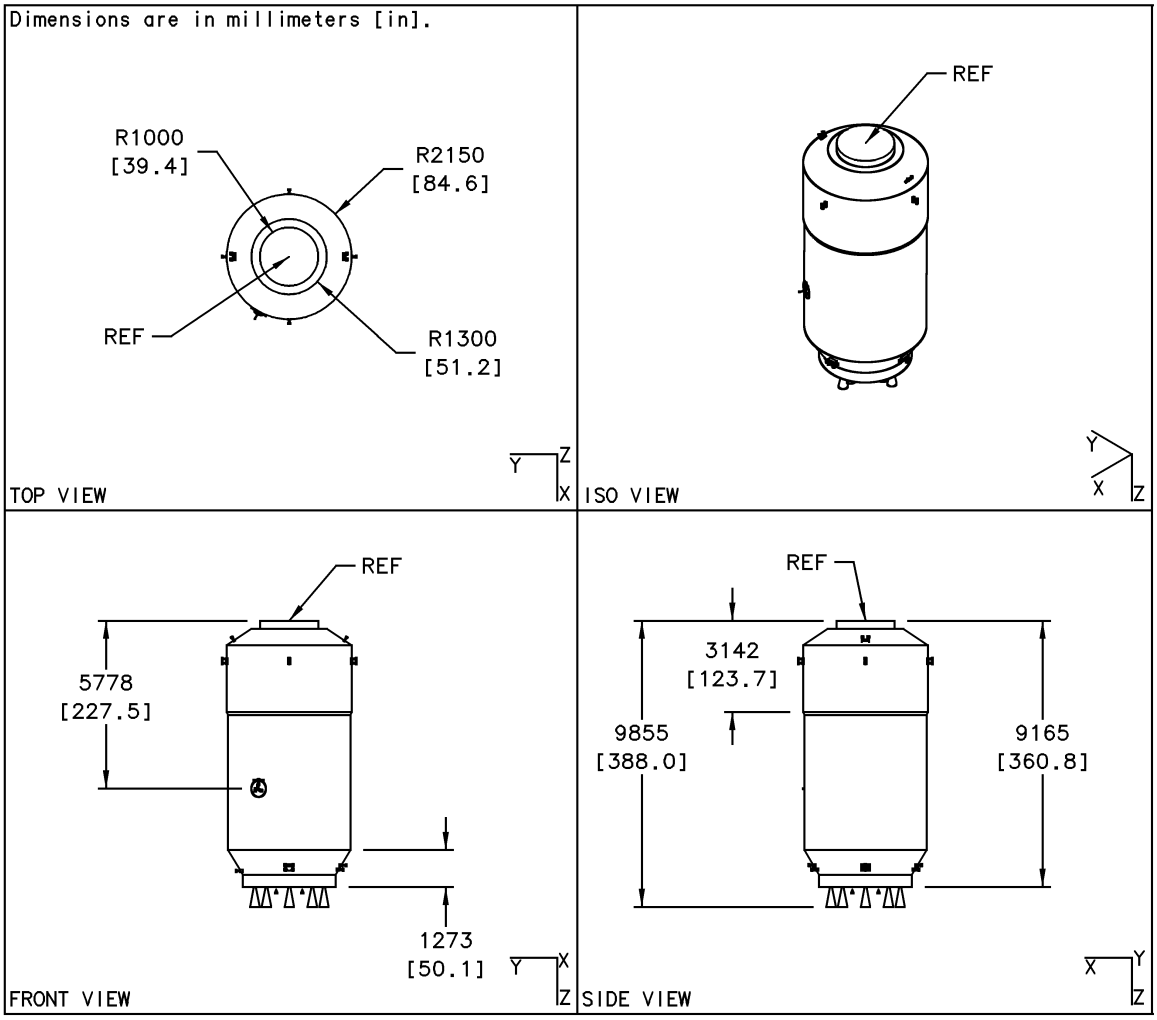
Stage 14A – Before Separation

Element Properties:

H II Transfer Vehicle (HTV)

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
143000	X =	10933	X =	10933	-46272	130300	0	0
	Y =	4	Y =	4	-2716	0	130300	0
	Z =	10298	Z =	6858	-10	0	0	41300

Reference Point Description: Center of zenith docking plane to Node 2 Nadir CBM



STEP 006

Stage 14A – Before Separation

Element Properties:

Density Lab Module 14A Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
25631	X =	2007	X =	6302	-41641	70528	-1722	-3852
	Y =	-78	Y =	7	-712	-1722	167269	502
	Z =	4887	Z =	4854	-13	-3852	502	180522

Reference Point Description: Center of forward CBM interface

Soyuz at DC1

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
6745	X =	-23712	X =	-23701	-11638	24557	-1	6
	Y =	12	Y =	-6	-5166	-1	23644	0
	Z =	13458	Z =	9308	0	6	0	4675

Reference Point Description: Center of zenith docking plane

JEM EF at 14A Stage

Mass [kg]	Center of Mass [mm]		Reference Point	ISS [mm]	RSA [mm]	Inertia Tensor [kg*m^2]		
6074	X =	12308	X =	11712	-47051	15864	0	0
	Y =	-16304	Y =	-18151	-4776	0	8525	0
	Z =	6570	Z =	8918	18145	0	0	21155

Reference Point Description: Center of keel pin

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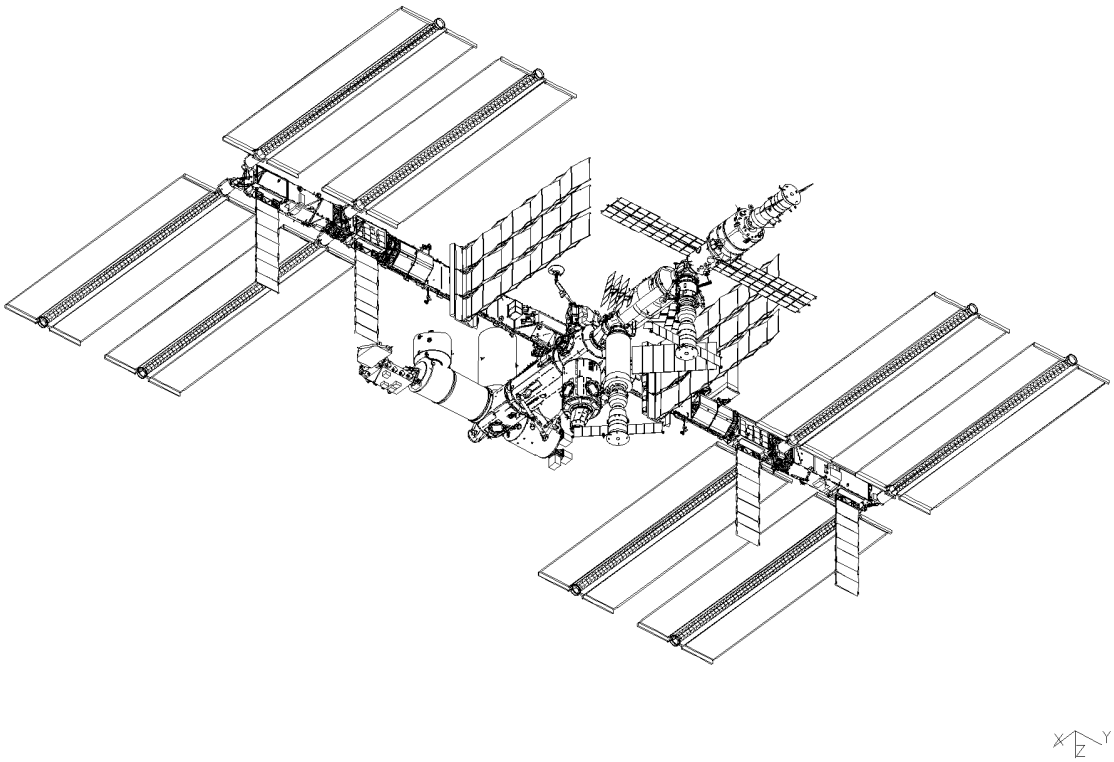
Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 006		
M. Falou/LM/281-333-6326	Stage 14A ISS – After Separation		
Produced By	Contract		Item Number
Brad Henry	NAS9-19100 Science Engineering Analysis & Test		03-DR0012
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/30/03



Technical Monitor	Title		
T. Farrell/EA4/281-483-8123	International Space Station Program		
Approved By	Step 006		
M. Falou/LM/281-333-6326	Stage 14A ISS – After Separation		
Produced By	Contract		Item Number
Jeff Froemming	NAS9-19100 Science Engineering Analysis & Test		03-MP0037
	NASA Center/Division	Revision	Date
	JSC/Systems Engineering Office	Original	06/13/03

```
Total mass:              815155. lb
                         369748. kg

Center of mass:
                            X           Y           Z
                         -11.32         .61       12.34 ft
                          -3.45         .19        3.76 m

Inertia tensor*:
                                    slug*ft**2
                        84435912.    1712217.    3738058.
                         1712217.   50120508.    1491853.
                         3738058.    1491853.  123433536.

                                     kg*m**2
                       114479672.    2321454.    5068124.
                         2321454.   67954256.    2022681.
                         5068124.    2022681.  167353328.

Principal moments of inertia (IXX, IYY, IZZ):
                        84149929.   50010424.  123821618. slug*ft**2
                       114095472.   67807104.  167884704. kg*m**2

Principal to body roll, pitch, yaw in a 1 2 3 sequence:
                            1.03       -5.53       -2.64 degrees

Center of pressure:
(WRT CM)                     X ft        Y ft        Z ft
                    CPx   .00E+00   -1.21E-01   -5.59E-01
                    CPy -2.02E+01     .00E+00   -7.12E-02
                    CPz  6.68E+00   -1.53E+00     .00E+00

                           X m         Y m         Z m
                    CPx   .00E+00   -3.68E-02   -1.70E-01
                    CPy -6.16E+00     .00E+00   -2.17E-02
                    CPz  2.04E+00   -4.67E-01     .00E+00

Projected areas:
                            X           Y           Z
                         8893.85     6433.72    33424.65 ft**2
                          826.27      597.71     3105.25 m**2

*Off-diagonal elements are negative integrals
```

APPENDICES

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APPENDIX A
ACRONYMS AND ABBREVIATIONS

A

A	American
A/R	American/Russian
AMS	Alpha Magnetic Spectrometer
APAS	Androgynous Peripheral Attach System
APFR	Articulating Portable Foot Restraint
AR	After Rendezvous
AS	After Separation
ATV	Automated Transfer Vehicle

B

BPM	Biological Production Module
BS	Before Separation
BSP	Band Signal Processor

C

CAD	Computer Aided Design
CAM	Centrifuge Accommodations Model
CBM	Common Berthing Mechanism
CETA	Crew and Equipment Translation Assembly
COF	Columbus Orbital Facility
CP	Center of Pressure or Cold Plate
CSA	Canadian Space Agency

D

DC	Docking Compartment
DCN	Design Change Notice
DCSU	Direct Current Switching Unit
DDCU	Direct current-to-Direct current Converter Unit

E

EA4	Systems Engineering Office [NASA/JSC]
EAS	Early Ammonia Servicer
EATCS	External Active Thermal Control System
EDS	Electronic Data Systems
EEATCS	Early External Active Thermal Control System
EF	Exposed Facility
ELM-ES	Experimental Logistics Module Exposed Section
ELM-PS	Experimental Logistics Module Pressurized Section
ESA	European Space Agency
ESP	External Stowage Platform
EVA	Extravehicular Activity

F

FGB	Functionalni Gruzvoi Blok [Russian] (Functional Cargo Block)
FPMU	Floating Potential Measurement Unit
ftp	File Transfer Protocol

G

H

HPGA	High Pressure Gas Assembly
http	hypertext transfer protocol
HTV	H-II Transfer Vehicle

I

I-DEAS	Integrated Design Engineering Analysis Software
ICC	Integrated Cargo Carrier
IGES	International Graphics Exchange Standard
INT	Intermediate

ISS	International Space Station
ISSP	International Space Station Program
ITS	Integrated Truss Segment

J

JEM	Japanese Experimental Module
JSC	(Lyndon B.) Johnson Space Center

K

KhSC	Khrunichev State Research and Production Space Center
Ku-Band	15.250 to 17.250 Gigahertz

L

LCA	Laboratory Cradle Assembly
LEE	Latching End Effector
LM	Lockheed Martin
LMSO	Lockheed Martin Space Operations
LVLH	Local Vertical/Local Horizontal

M

MBS	MRS Base System
MBSU	Main Bus Switching Unit
MISSE	Materials ISS Experiment
MOD	Mission Operations Directorate
MODGEN	*MODel GENerator*
MPAC	Micro-Particle Capture
MPLM	Multi-Purpose Logistics Module
MBSU	Main Bus Switching Unit
MPVSET	Mass Properties Verification and Sustaining Engineering Tool
MRS	Mobile Remote Servicer
MT	Mobile Transporter

MTsM	Mnogo Tselevoi Modul [Russian] (Multi Purpose Module)

N

NASA	National Aeronautics and Space Administration [United States]
NASDA	National Space Development Agency [Japan]
NSTS	National Space Transportation System

O

ODS	Orbiter Docking System
OM	ISS Mission Integration Office (organization code)
ORU	On-orbit Replacement Unit; Orbital Replacement Unit
OSE	Orbital Support Equipment
OSRS	Orbiter Structural Reference System
OTD	ORU Transfer Device
OV	Orbiter Vehicle

P

P	Progress; Port
PAS	Payload Attachment System
P1	Port 1
PDGF	Power and Data Grapple Fixture
PFCS	Pump and Flow Control Subassembly
PFRWS	Portable Foot Restraint Work Station
PIT	Physical Integration Team [Boeing]
PM	Pressure Module; Propulsion Module
PMA	Pressurized Mating Adapter
POA	Payload ORU Accomodation
POF	Port Outboard Forward
PV	Photovoltaic
PVRGF	Photovoltaic Removable Grapple Fixture
PVTCS	Photovoltaic Thermal Control System

PWP	Portable Work Platform

R

R	Russian
RAI	Resource Analysis and Integration
RMS	Remote Manipulator System
RPO	Research Program Office
RSA	Russian Space Agency
RSC-E	Rocket Space Corporation-Energia

S

S	Soyuz
SARJ	Solar Alpha Rotary Joint
SDRC	Structural Dynamics Research Corporation
SEED	Space Environment Exposure Device
SEMDA	Systems Engineering, Modeling, and Design Analysis
SHOSS	Spacehab Oceaneering Space System
SOA	Starboard Outboard Aft
SODB	(Space) Shuttle Operational Data Book
SOF	Starboard Outboard Forward
SPDM	Special Purpose Dexterous Manipulator
SPP	Science Power Platform
SSACS	Space Station Analysis Coordinate System
SSCB	Space Station Control Board
SSP	Space Shuttle Program
SSRMS	Space Station Remote Manipulator System
STS	Space Transportation System

T

TCS	Thermal Control System
TIM	Technical Interchange Meeting

TM	Transport Spacecraft, Modified

U

UF	Utilization Flight
UHF	Ultra High Frequency
ULF	Utilization Logistic Flight
UT	Universal Translator

V

VAC	Verification Analysis Cycle
VIPeR	Vehicle Integrated Performance and Resources [team]
VSSA	Video Stanchion Support Assembly

W

WETA	WVS External Transceiver Assembly
WIF	Worksite Interface
WVS	Wireless Video Systems

X, Y, Z

Z1	Zenith 1

APPENDIX B

COMPONENT DEFINITIONS
PREFIXES

P1	First port truss section, outboard of the middle truss section
P3	Second port truss section, outboard of P1
P4	Third port truss section, subject to alpha rotation
P5	Fourth port truss section, subject to alpha rotation
P6	Fifth port truss section (subject to alpha rotation)
PIA	Port inboard aft
PIF	Port inboard forward
POA	Port outboard aft
POF	Port outboard forward
S0	Zero, or Middeck truss section, formerly called M1
S1	First starboard truss section, outboard of middle ITA
S3	Second starboard truss section, outboard of S1
S4	Third starboard truss section, subject to alpha rotation
S5	Fourth starboard truss section, subject to alpha rotation
S6	Fifth starboard truss section, subject to alpha rotation
SIA	Starboard inboard aft
SIF	Starboard inboard forward
SOA	Starboard outboard aft
SOF	Starboard outboard forward
Z1	Zenith, first truss section on Node 1

COMPONENT DEFINITIONS (continued)
SUFFIXES

xx_AS	After Separation: A free-flying configuration immediately after Orbiter or Progress vehicle undocking.
xx_AR	After Rendezvous: An Orbiter-attached configuration immediately after docking and before payloads unloaded, a Space Shuttle mission phase.
xx_INTx	Intermediate: An Orbiter-attached configuration partially unloaded, a potential Space Shuttle mission phase. A number after 'INT' designates one of multiple intermediate configurations. No number indicates that a single intermediate configuration exists.
xx_BS	Before Separation: An Orbiter-attached configuration immediately before undocking and after payloads unloaded, a Space Shuttle mission phase.
xS_ARx	Soyuz Relocation: A configuration after a Soyuz undocks, moves to another location, and re-docks to the ISS. The number before 'S' indicates the stage that the Soyuz vehicle was launched.

APPENDIX C
DATA BOOK SPECIFICATIONS

ITEM	VARIABLE	SPECIFICATION
VOLUMES	TWO	I and II
VERSION	NUMBER	JSC 26557 REVISION P; VOLUME I and II
VERSION	NUMBER	LESC 31166 REVISION P; VOLUME I and II
MANUAL	SOFTWARE	*MICROSOFT WORD 2000*
COVER	FONT SIZE	Arial 10, 12,18, 20, 24-point
PAGE	SIZE	8 ½-inch X 11-inch
PAGE	FORMAT	Portrait and Landscape (Figures or Tables)
LOGO	NASA	*MICROSOFT WORD*
LOGO	LOCKHEED MARTIN	*MICROSOFT WORD*
TEXT	ACRONYMS	Identified once at first use only
TEXT	FONT	Arial 12-point
TEXT	HEADINGS	No **Bold**; no underlines; ALL CAPS; Left
TEXT	MARGINS	Left: 1.2-inches; others 1-inch; mirror pages
TEXT	SPACING	Flush left; ragged right
TEXT	INDENT	¼-inch then ½-inch
TEXT	LISTS	Bullets unless order is required
TABLES	TITLE/TEXT	Title at top; Arial 10-point
FIGURES	TITLE/TEXT	Title at bottom; Arial 12-point
HEADER	RIGHT CORNER	JSC Document number, revision, volume
REFERENCE	DOCUMENT/SOFTWARE	*Italics*
FOOTER	RIGHT CORNER	LESC Document number, revision, volume
FOOTER	PAGE NUMBERS	1-1, 2-1, 3-1, 4-1, 5-1, 6-1, 7-1
FOOTER	APPENDICES PAGES	A-1, B-1, C-1, IND-1
HEADER/FOOTER	FONT SIZE	Arial 9-point
PAGE	Blanks	“This page included for formatting purposes.”

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APPENDIX D
SOLAR ARRAY AND SARJ ROTATIONAL CONVENTIONS

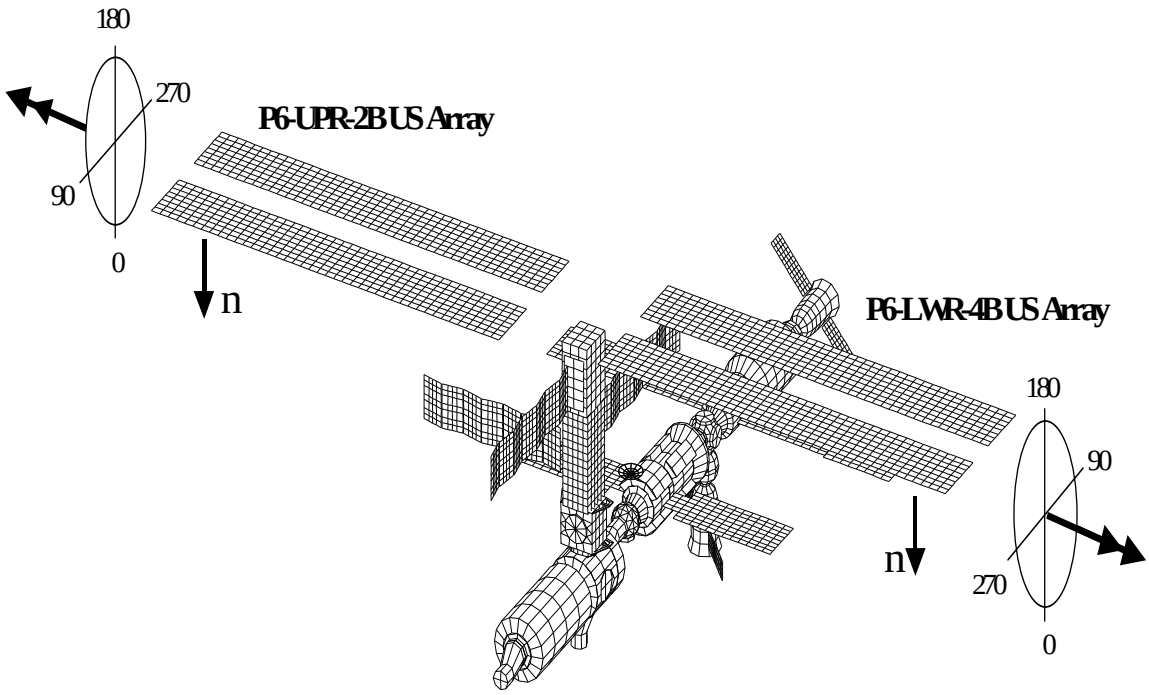

Figure D-1 US Solar Array Conventions Phase 1 Complete

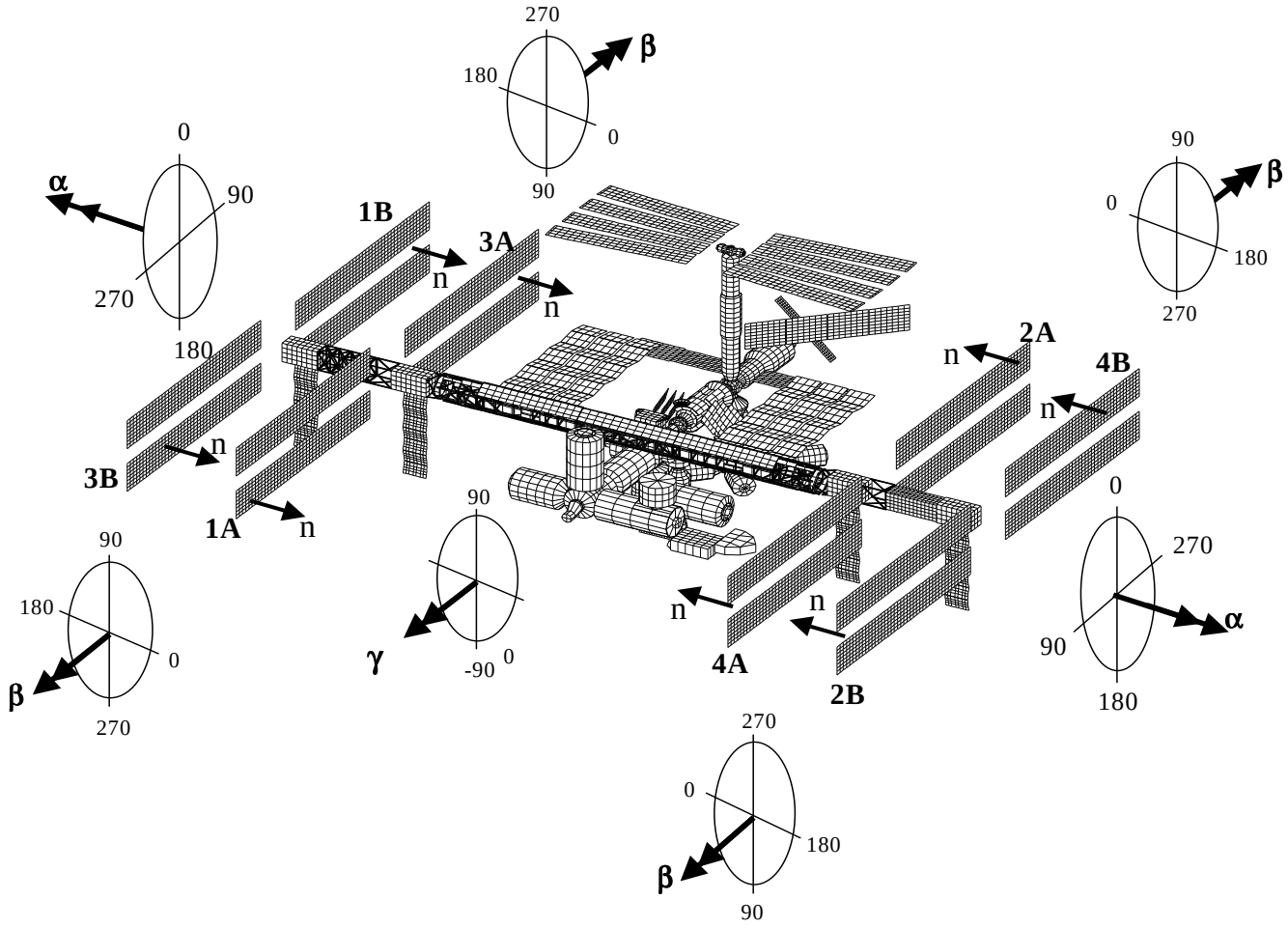

Figure D-2 US Segment Solar Array & Radiator Conventions Assembly Complete

APPENDIX E
WORKSITE NAMING CONVENTIONS

WORKSITE	BOEING ITS BAY	MOD ITS BAY	ISS ITS BAY
NOMENCLATURE			
Worksite #1	S3B2	S3B2	S3B17
Worksite #2	S1B2	S1B2	S1B13
Worksite #3	S1B6	S1B6	S1B5
Worksite #4	S0B2	S0B2	S0B1
Worksite #5	S0B5	S0B5	S0B4
Worksite #6	P1B6	P1B1	P1B6
Worksite #7	P1B2	P1B5	P1B14
Worksite #8	P3B2	P3B1	P3B18
Worksite #9	S6B?	S6B?	S6B?
Worksite #10	P6B?	P6B?	P6B?

Table E-1 Naming Convention for the MT Worksites

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